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ABSTRACT

Education is an important contributor to productivity growth and has a major influence on the standard of living of the U.S. population. Economic productivity depends on human as well as physical capital. This report is the first in a series of indicator reports recommended by the congressionally mandated Special Study Panel on Education Indicators. The report examines the link between education and economic productivity from different angles using a variety of data sources. It first presents indicators related to historical trends in worker productivity in the United States and other countries and the contribution of education to these trends. The report also considers the link between education and productivity at the individual level, focusing on the economic consequences of educational attainment, educational achievement, and adult literacy. The link between worker training and productivity is also explored. Finally, the report compares key measures of educational performance in the U.S. with corresponding measures in other countries. The indicators in the report come from many data sources, including the National Center for Education Statistics as well as other federal and international statistical agencies. The report examines the existing research on the indicators and related issues, presenting arguments and conclusions from researchers on all sides of the issues. Eight tables and 57 figures are included. (Contains 88 references). (LMI)

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EDUCATION AND THE ECONOMY:

An Indicators Report

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EDUCATION AND THE ECONOMY:
An Indicators Report

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April 1997

U.S. Department of Education
Office of Educational Research and Improvement **NCES 97-269**

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COMMISSIONER'S STATEMENT

This report on *Education and the Economy* is the first in a series of indicator reports recommended by the congressionally mandated Special Study Panel on Education Indicators. In its report, *Education Counts*, the panel challenged the National Center for Education Statistics (NCES) to make a major advance in indicator reporting by going ". . . far beyond the kinds of indicator information now reported by the federal government . . . bringing multiple indicators from a variety of data sources to bear on the issue and linking the indicators together with analytic commentary and interpretation." The panel focused specifically on six policy issue areas in which the public would benefit from more synthesis and interpretation of the available data. In this time of concern about U.S. economic competitiveness, we have chosen the link between education and economic productivity as the topic for this first indicator report.

Information about the contribution of education to productivity is important to the Department of Education, since our mission includes equal access to education and the promotion of educational excellence throughout the nation. Economic productivity depends on human as well as physical capital. Workers can accumulate human capital, and thereby increase their productivity, by advancing their skills through education and training. Worker productivity is a critical determinant of workers' pay and living standards; hence, high quality education, by enhancing worker productivity, is a key contributor to the economic success of workers and the population as a whole. Any deficiencies in the United States educational system could harm entrants to the labor force by jeopardizing the productivity of these entrants.

In this report, we examine the link between education and economic productivity from different angles using a variety of data sources. First, we present indicators related to historical trends in worker productivity in the United States and other countries and the contribution of education to these trends. We also consider the link between education and productivity at the individual level, focusing on the economic consequences of educational attainment, educational achievement, and adult literacy. Since accumulation of human capital does not end with formal schooling, we also explore the link between worker training and productivity. Finally, we compare key measures of educational performance in the United States with corresponding measures in other countries.

The indicators in this report come from many data sources, including NCES as well as other federal and international statistical agencies. In addition, we examine the existing research on the indicators and related issues, presenting arguments and conclusions from researchers on all sides of the issues. Our hope is that the report will inform the public about the role of education in determining the economic well-being both of the nation and of individuals, and that the report will serve as a model for future indicator reports recommended by the indicators panel.

Pascal D. Forgione, Jr.
Commissioner

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The authors would like to thank Jeanne Griffith, John Ralph, Nabeel Alsalam, Mary Frase, and Thomas Smith of the National Center for Education Statistics (NCES), U.S. Department of Education, for their valuable guidance and advice during the study. James Houser of NCES managed the production of this report as it neared completion. We also received helpful comments from Kenneth Voytek, Andrew Kolstad, Steve Broughman, Paul Barton, John Bishop, Ed Wolff, Audrey Pendleton, Dave Boesel, Sue Berryman, George Psacharopoulos, and Jim Stedman. At Mathematica Policy Research, Daryl Hall edited the report; Deborah Patterson, Michelle Taylor, Connie Blango, and Melanie Lynch produced the report; and Robert Howard and Michael Stavrianos helped collect the data for the report.

The authors also wish to thank the Production group at MPR Associates, Inc. for their help in producing the final report. Leslie Retallick designed and composed the report and Mary Sukkestad and Don Eike developed the graphics. Barbara Kridl managed the project and, with Karyn Madden, proofread the final copy.

EXECUTIVE SUMMARY

The productivity of the U.S. work force is a primary determinant of the standard of living of the U.S. population. Worker productivity is typically measured as output per worker or per hour worked. It is affected by many factors, including the education and skills of the work force. Education and skills are important because they expand a worker's capacity to perform tasks or to use productive technologies. In addition, better educated workers can adapt more easily to new tasks or to changes in old tasks. Education may also prepare workers to work more effectively in teams because it enhances their ability to communicate with and understand their co-workers.

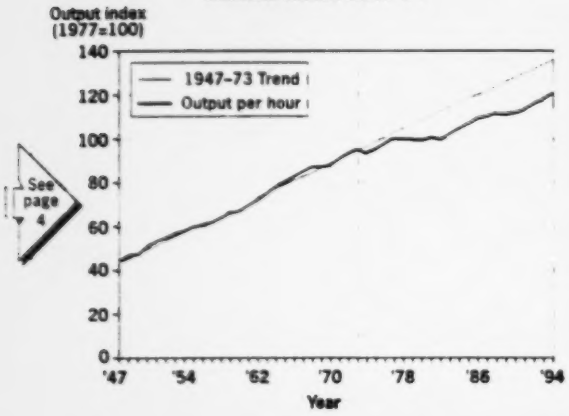
Much of the recent concern about the productivity of U.S. workers has been prompted by uncertainty about the ability of domestic firms and workers to compete in an increasingly international marketplace. As growth in U.S. productivity has slowed over the past two decades and other countries achieve productivity levels similar to those in the United States, concern about the competitiveness of U.S. firms and workers has increased. Some attribute the loss of the nation's productivity advantage to what they claim is the limited ability of the U.S. educational system to provide students with the skills necessary to succeed in today's labor market. However, factors other than education also affect productivity, and these must be considered when comparing productivity trends across countries.

Variation in the quality and quantity of education across countries is only one factor contributing to differences in worker productivity; capital investment, technical innovation, foreign trade, and government regulation can also affect productivity. Nevertheless, education remains an important contributor to productivity growth and has a major influence on the standard of living. This essay highlights several measures of productivity and education, and addresses the link between these two sets of measures. A better understanding of the relationship between worker productivity and the condition of education is essential to understand how investment in education contributes to the U.S. economy.

Trends in Worker Productivity and the Contribution of Education

Worker productivity in the United States has increased almost continuously since the end of World War II, but growth has slowed since 1973.

Figure A
Index of real output per hour of all persons, business sector: 1947–94



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NOTE: Figures for years after 1988 were originally based on 1982=100. They were multiplied by a factor of 1.013 for use in the 1977=100 index. Hours of all persons include hours of employees, proprietors, and unpaid family workers. Output is the constant-dollar market value of final goods and services produced. For the business sector, the index relates to gross domestic product (GDP) less general government, output of nonprofit institutions, output of paid employees of private households, and rental value of owner-occupied dwellings. Business output was about 78 percent of GDP in 1992.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics*, Washington, DC: U.S. Government Printing Office, 1989; *Monthly Labor Review* 18 (8) (August 1995): 175.

Worker productivity in the United States has grown almost continuously since the end of World War II, rising to a level in 1994 that is approximately three times that of 1947 (figure A). Post-war growth in productivity was slower after 1973 than it was before 1973. From 1947 through 1973, output per hour increased by nearly 3 percent per year, compared to slightly more than 1 percent per year from 1973 through 1994. It is unclear whether the slowdown in productivity growth since 1973 merely reflects fluctuation around the long-term growth rate, which is equal to about 2 percent, or whether it signals slower long-term growth.

Since World War II, worker productivity has grown more slowly in the United States than in other industrialized countries.

For several decades, productivity in other industrialized countries has been gradually catching up to that in the United States (figure B). However, the United States remained the leader as of 1990, with a gross domestic product (GDP) per worker that was slightly higher than that in Canada, and about 25 percent higher than that in Italy, the country with the third highest GDP per worker.

According to one theory of productivity growth, referred to as the *convergence hypothesis*,[1] it is to be expected that productivity in lagging countries will converge on that of the United States because these countries can exploit technologies transferred from the United States, thereby closing the gap in worker productivity. This "catching-up" process suggests that the United States is inevitably at risk of losing

[1]Moses Abramovitz, "Catching Up, Forging Ahead, and Falling Behind," *Journal of Economic History* 46 (June 1986): 385–406.

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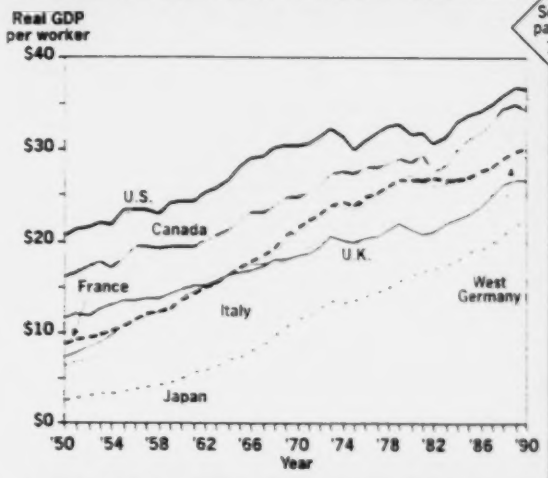
its lead in worker productivity as long as other countries have the capabilities, including an adequately educated work force, to exploit new productive technologies.

The ability of the United States to have maintained a substantial lead in productivity for nearly a century is at least partly attributable to the two world wars, which destroyed the productive capacity of other countries while spurring technological innovation in U.S. manufacturing. However, the huge productivity advantage of the United States has dissipated under the more normal post-war economic conditions, which have allowed other countries to rebuild their productive capacities and expand their technological capabilities. It now appears that the other industrialized countries may eventually share the lead in productivity with the United States.

Figure B
Real GDP per worker in G–7 nations: 1950–90
(in thousands of dollars based on 1985 international prices)



See page 7

SOURCE: Penn World Table (Mark 5.6), distributed by the National Bureau of Economic Research. For a description, see Robert Summers and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–1988," *Quarterly Journal of Economics* (May 1991): 327–368.

But insofar as the "catching-up" process involves the transfer of technology from the leader country to the lagging countries, the process should eventually slow down as the lagging countries exhaust their opportunities to exploit new technologies from the leader. Eventually, the countries sharing the lead in productivity would presumably be in a position to exploit technological advances from each other.

Growth in education has historically been an important source of growth in worker productivity.

Increases in educational attainment were responsible for an estimated 11 to 20 percent of growth in worker productivity in the United States in recent decades.[2] Growth in factors other than education have also contributed to growth in worker productivity. For example, increases in capital accounted for an estimated 40 percent of growth in worker productivity in the United States from 1948 to 1990.[3]

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[2]U.S. Department of Labor, Bureau of Labor Statistics, *Labor Composition and U.S. Productivity Growth, 1948–90*, Bulletin 2426 (Washington, D.C.: U.S. Government Printing Office, 1993); Dale W. Jorgenson, "The Contribution of Education to U.S. Economic Growth, 1948–73," in E. Dean, ed., *Education and Economic Productivity* (Cambridge, MA: Ballinger, 1984); Edward F. Denison, *Accounting for Slower Economic Growth: The United States in the 1970s* (Washington, D.C.: Brookings Institute, 1979); and Jong-Il Kim and Lawrence Lau, "Human Capital and Aggregate Productivity: Some Empirical Evidence from the Group-of-Five Countries," unpublished paper (Palo Alto, CA: Stanford University, 1992).

[3]U.S. Department of Labor, Bureau of Labor Statistics, *Labor Composition and U.S. Productivity Growth, 1948–90*, Bulletin 2426 (Washington, D.C.: U.S. Government Printing Office, 1993).

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In addition to capital, such factors as technical innovation, foreign trade, and government regulation can also affect productivity.

The historical contributions of these factors affecting productivity are not necessarily indicative of the relative returns to potential investments in the factors. They simply reflect the linking of the relative growth rates of each factor over the past several years to the productivity growth rate. The growth accounting methods used to determine these sources of productivity growth cannot be used to identify future preferred input investments.

Education appears to play an important role in worker productivity in all industrialized countries. The industrialized countries with the highest productivity levels tend to have highly educated work forces, and the convergence in productivity among these countries generally parallels that in educational attainment.

The Economic Consequences of Education for Individuals

Ultimately, growth in a nation's productivity results from growth in the productivity of individual workers. The best available measure of a worker's productivity is that worker's wages, as employers generally pay wages equal to the marginal productivity of their workers. The impact of education on the productivity of workers can be determined by estimating the impact of education on wages.

Education may also improve workers' employment stability, enabling more educated workers to maintain their jobs or to quickly find new jobs in the face of changing economic conditions. Therefore, the association between education and unemployment can be a further indication of the effect of education on the productivity of workers.

Educational Attainment

Workers with higher educational attainment are unemployed less and earn more than workers with lower educational attainment.

Over the past 30 years, a substantial proportion of high school graduates and dropouts were unemployed shortly after leaving high school, with dropouts generally facing a higher unemployment rate than graduates (figure C). In 1994, 30 percent of recent dropouts were unemployed, compared to 20 percent of recent graduates not enrolled in college. The unemployment rates for both groups have increased since 1960.

Median earnings are positively associated with educational attainment (figure D). Among males ages 25–34 years in 1993, median earnings of those with a college degree were equal to about $33,000 per year, which was more than 50 percent greater than the median earnings of high school graduates and more than twice those of high school dropouts. The relationship between education and earnings for females is similar, although within each educational category, earnings are lower for females than for males.

Figure C
Unemployment rate of recent high school graduates and dropouts not enrolled in college: 1960–94

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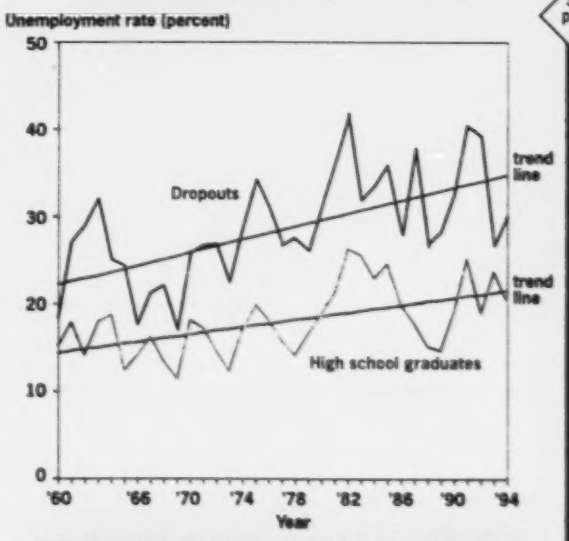

NOTE: Recent high school graduates include individuals ages 16–24 years who graduated during the survey year and were not enrolled in college. Recent high school dropouts include individuals ages 16–24 years who did not graduate and who were in school 12 months earlier, but who were not enrolled in the survey month.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*, and special tabulations; U.S. Department of Commerce, Bureau of the Census, October Current Population Surveys.

■ ***Educational attainment in the United States has increased over the past 20 years.***

The proportion of 18- to 24-year-olds who have completed high school has increased slowly, rising from approximately 83 percent in 1972 to about 86

Figure D
Earnings for all wage and salary earners ages 25–34 years, by sex and educational attainment: 1993

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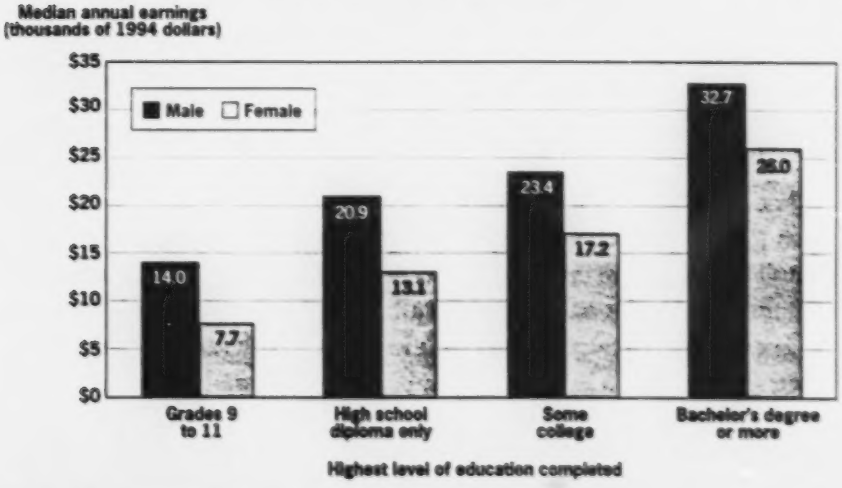

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*; U.S. Department of Commerce, Bureau of the Census, March Current Population Survey, 1994.

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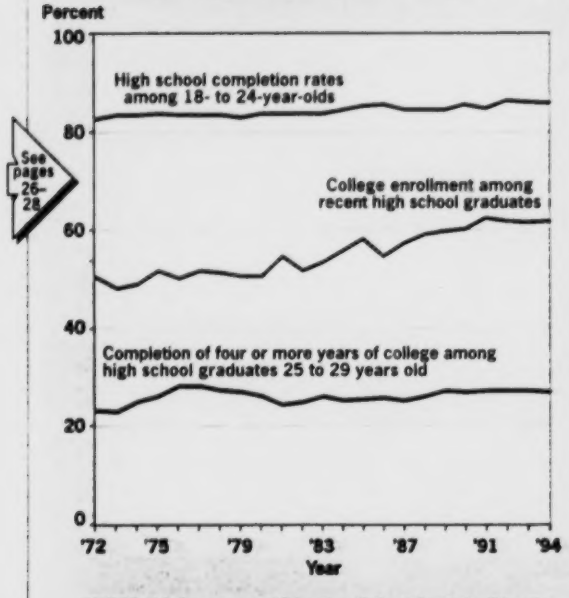
Figure E
High school completion, college enrollment, and college completion rates: 1972–94



See pages 26–28

SOURCE: U.S. Department of Education, National Center for Education Statistics, *Dropout Rates in the United States: 1994*; U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995* and *The Condition of Education, 1996*; U.S. Department of Commerce, Bureau of the Census, October and March Current Population Surveys.

percent in 1994 (figure E). An increasing number of students who have completed high school also move on to college. Among recent high school graduates, the college enrollment rate increased from 49 percent in 1972 to 62 percent in 1994.

However, many students who enroll in college do not complete four years there. The completion rate of 27 percent in 1994 was only slightly higher than the rate of 20 years before.

■ ***Although the rate of college completion in the United States still far exceeds that in most other countries, educational attainment generally is increasing more slowly in the United States than in other industrialized countries.***

In each of the G–7 countries, the rate of secondary school completion is higher among 25- to 34-year-olds than among 25- to 64-year-olds, indicating that the rate of secondary school completion is increasing in these countries (figure F). Moreover, the gap between the completion rates of younger and older workers is larger in other G–7 countries than in the United States, suggesting that secondary school attainment is increasing at a faster rate in the other countries. The high school completion rates for young adults in Japan and Germany are now comparable to those of young adults in the United States, while the rates for young adults in Canada and the United Kingdom are approaching those of their counterparts in the United States.

Most G–7 countries still lag well behind the United States in higher education attainment (figure G). The proportion of the population ages 25–64 years who have completed a college education is by far the highest in the United States. Although the U.S. lead is smaller for adults ages 25–34 years, only Japan has a rate of higher education attainment among young adults comparable to that in the United States. The rate of college completion among young American adults has risen slightly during the past 20 years, while the rate for young adults in Japan has risen dramatically; thus, Japan has nearly caught up to the United States. The rate of higher education attainment in most other G–7 countries has increased more slowly than that in Japan, as indicated by the smaller attainment gaps between younger and older adults in those countries.

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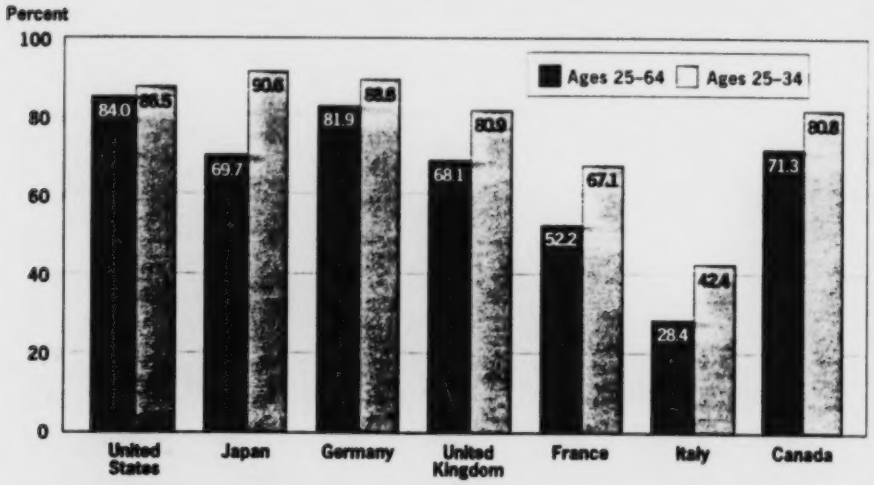
Figure F
Secondary school completion, by age: 1992



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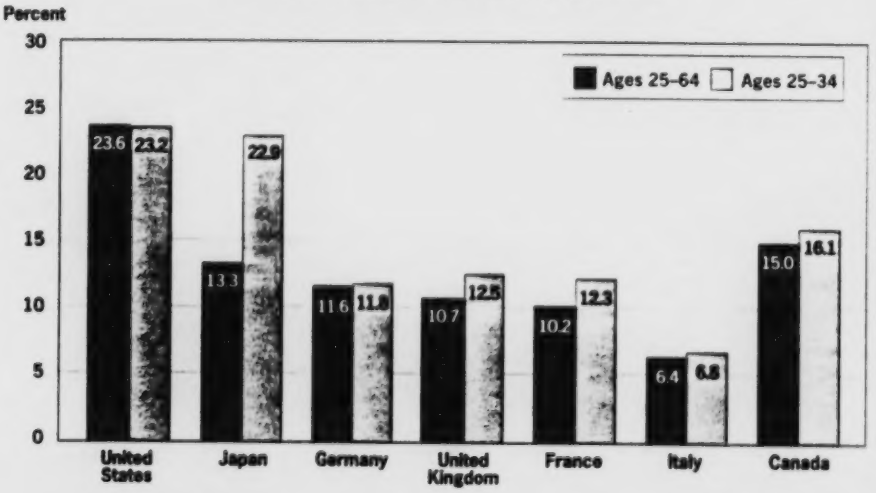
NOTE: In the United States, completing secondary school is defined as graduating from high school or earning a GED.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*; Organization for Economic Cooperation and Development, Indicators of Education's Systems, *Digest of International Education Statistics*, forthcoming.

Figure G
Completion of higher education, by age: 1992



See page 84

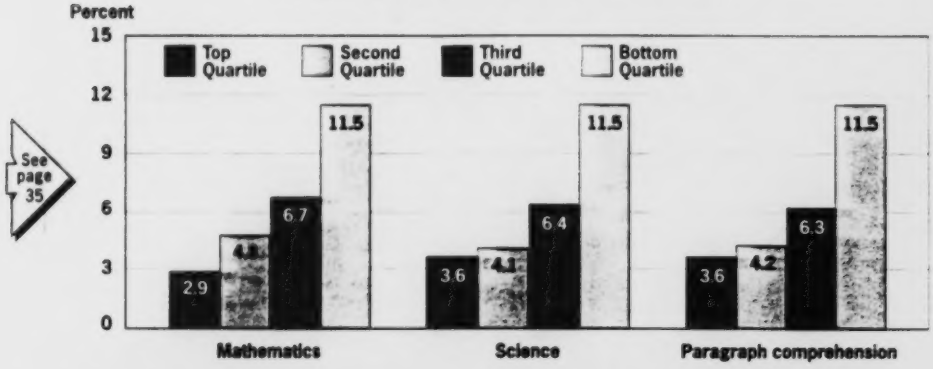
NOTE: In the United States, completing higher education is defined as earning a bachelor's degree.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*; Organization for Economic Cooperation and Development, Indicators of Education's Systems, *Digest of International Education Statistics*, forthcoming.

Educational Achievement

Workers who have a record of high academic achievement, as measured by achievement test scores, are unemployed less and earn more than workers with lower scores.

Figure H
Unemployment rate of civilian workers age 28 years, by age-adjusted ASVAB score quartile: 1985–93



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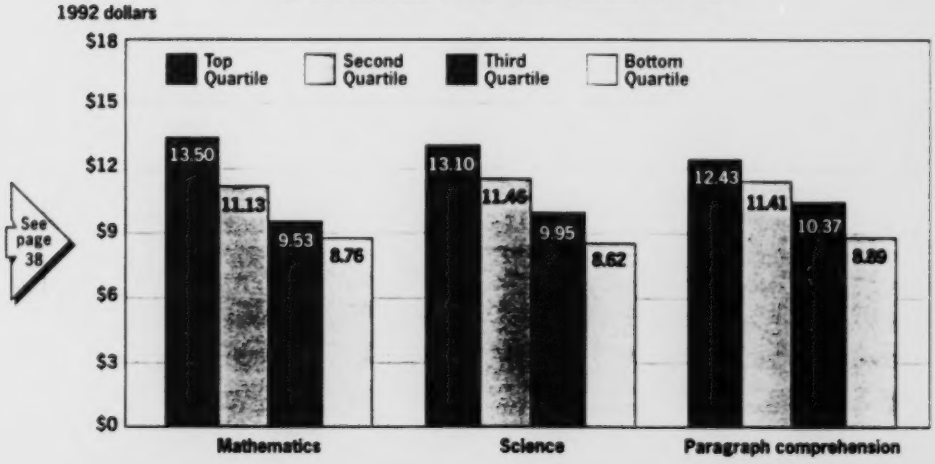
NOTE: ASVAB is the Armed Services Vocational Aptitude Battery. To control for differences in age at testing, individuals were assigned to age-specific performance quartiles for each subject area based on their age at testing. Respondents who were out of the labor force were excluded from the sample.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Longitudinal Survey of Youth, 1985–93.

Figure I
Mean hourly rate of pay for civilian workers age 28 years, by age-adjusted ASVAB score quartile: 1985–93



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NOTE: ASVAB is the Armed Services Vocational Aptitude Battery. Respondents reporting hourly pay of less than $1.00 or greater than $100.00 (1992 dollars) at any given age were excluded from the sample for that age. To control for differences in age at testing, individuals were assigned to age-specific performance quartiles for each subject based on their age at testing.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Longitudinal Survey of Youth, 1985–93.

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Workers who are 28 years old and who have previously scored in the top quartile on the Armed Services Vocational Aptitude Battery (ASVAB) mathematics, science, or paragraph comprehension tests have a lower unemployment rate than other workers (figure H). For example, 2.9 percent of workers in the top quartile of the mathematics test are unemployed, compared to 7.5 percent of workers in the other three quartiles combined. Workers in the top quartile on the tests in each subject also earn more, on average, than other workers (figure I). For example, workers in the top quartile on the mathematics test earn an average of $13.50 per hour, compared to an average of $9.84 per hour for workers in the other three quartiles combined.

Test scores of U.S. students generally increased in the 1980s and 1990s, offsetting declines that occurred during the 1970s.

Among 17-year-old students, National Assessment of Educational Progress (NAEP) test scores increased from 1982 through 1992 (figure J). Increases in mathematics and science scores reversed a trend of declining scores that existed throughout the 1970s. By 1992, the scores in these subjects had recovered to the 1973 levels. NAEP reading scores of 17-year-old students have increased slowly and steadily since the early 1970s.

U.S. students trail students from many other countries in mathematics and science achievement, but U.S. students tend to lead in reading achievement.

Figure J
Trends in average U.S. achievement of 17-year-olds in science, mathematics, and reading: 1969–92

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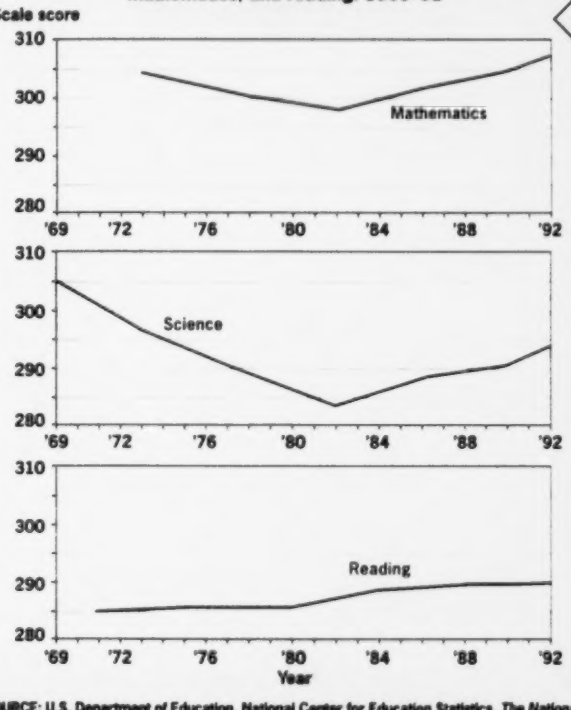

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The National Assessment of Educational Progress: 1992 Trends in Academic Progress*, 1994.

Most of the countries included in a 1991 international study of mathematics and science achievement outperformed the United States in the mathematics achievement of both 9-year-old and 13-year-old students (table A). With respect to science achievement, 9-year-old U.S. students performed as well as those in most other countries, but 13-year-old U.S. students scored below their counterparts in half of the other countries. In a separate international study of reading achievement, the United States led 20 of 22 countries in reading scores for 9-year-olds and was equivalent to or led 21 of 22 countries for 14-year-olds.

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Table A
International distribution of academic achievement relative to the United States: 1991–92

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Subject and age	Number of countries performing: Significantly higher than the U.S.	Not significantly different from the U.S.	Significantly lower than the U.S.	Number of countries in the study
MATHEMATICS				
9-year-olds	7	2	0	10
13-year-olds	12	1	1	15
SCIENCE				
9-year-olds	0	7	2	10
13-year-olds	7	6	1	15
READING				
9-year-olds	1	1	20	23
14-year-olds	1	14	7	23

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1993*; Warwick B. Elley, *How in the World Do Students Read?*, International Association for the Evaluation of Educational Achievement, Study of Reading Literacy, 1992; and Educational Testing Service, International Assessment of Educational Progress, 1992.

Adult Literacy

A 1992 study tested the performance of U.S. adults on three scales of literacy—prose, document, and quantitative—and categorized adults into five literacy levels according to their test scores, with level 1 being the lowest literacy level and level 5 being the highest.

■ ***Workers with higher literacy scores are unemployed less and earn more than workers with lower literacy scores.***

Unemployment rates are especially high for workers in the two lowest levels of literacy—levels 1 and 2—on each of the three literacy scales (figure K). For these workers, the unemployment rate ranges from 12 percent for workers with level 2 quantitative literacy to nearly 20 percent for those with level 1. Unemployment rates for individuals in the two highest literacy levels—levels 4 and 5—are less than 6 percent.

Workers with high literacy scores earn more than other workers, on average (figure L). On the prose scale, for example, full-time workers in level 3 earn a mean weekly wage that is 50 percent higher than that of their counterparts in level 1. Those in level 5 earn a weekly wage that is 71 percent higher than the wage of those in level 3.

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Figure K
Unemployment of adult labor force participants, by proficiency level on three literacy scales: 1992

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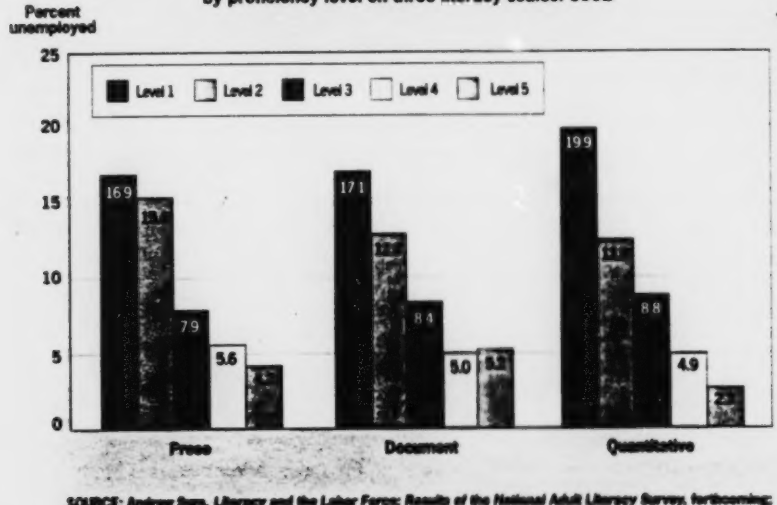

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

Figure L
Mean weekly earnings of full-time workers, by proficiency level on three literacy scales: 1992

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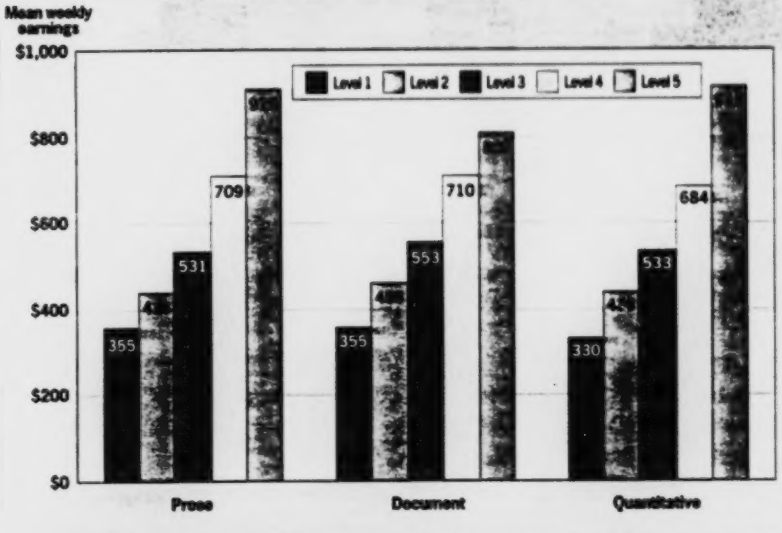

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

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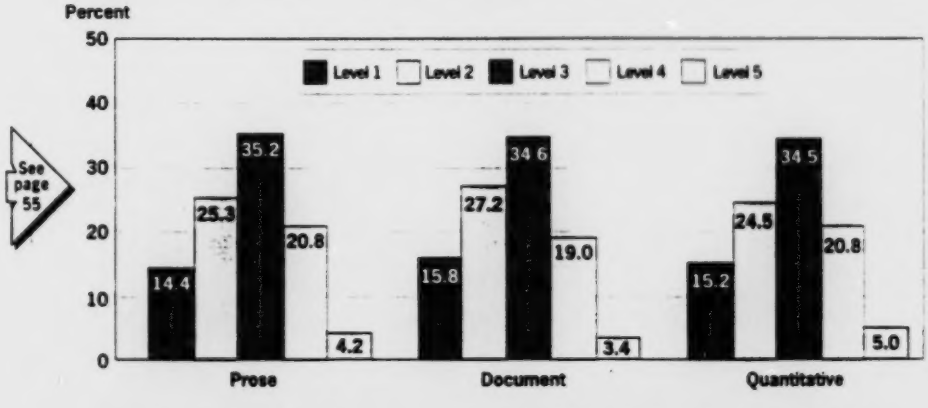
The literacy proficiency of a substantial proportion of the U.S. labor force is limited, and only a small proportion of workers perform at a high literacy level.

Forty percent or more of the adult labor force perform at the two lowest levels on each of the literacy scales, suggesting that many workers lack the skills needed to interpret, integrate, and compare or contrast information using written materials common to the home or workplace (figure M). These workers appear to be unable to perform the types of tasks typical of certain occupations that demand high skills, such as professional, managerial, technical, high-level sales, skilled clerical, or craft and precision production occupations. Five percent or fewer of U.S. labor force participants score in the highest proficiency levels, demonstrating an ability to perform well on a wide array of literacy tasks.

Figure M
Percentage of labor force in each proficiency level on the three literacy scales: 1992



See page 55

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

Literacy of the U.S. adult population is, on average, roughly similar to that of populations in other industrialized countries, but the United States has a greater proportion of adults at the lowest literacy levels.

On average, the proportion of the U.S. population in the highest literacy levels is similar to that in the other countries included in an international study of adult literacy (figure N). However, the United States has a higher concentration of adults in the lowest literacy level than nearly all of the other countries. More than 20 percent of the U.S. sample scored at the lowest literacy level on each of the three literacy scales, while the other countries (except Poland) had less than 20 percent of the sampled population scoring at the lowest level on each scale.

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Figure N
Estimated percentage of the population in each proficiency level on three adult literacy scales, by selected countries: 1994

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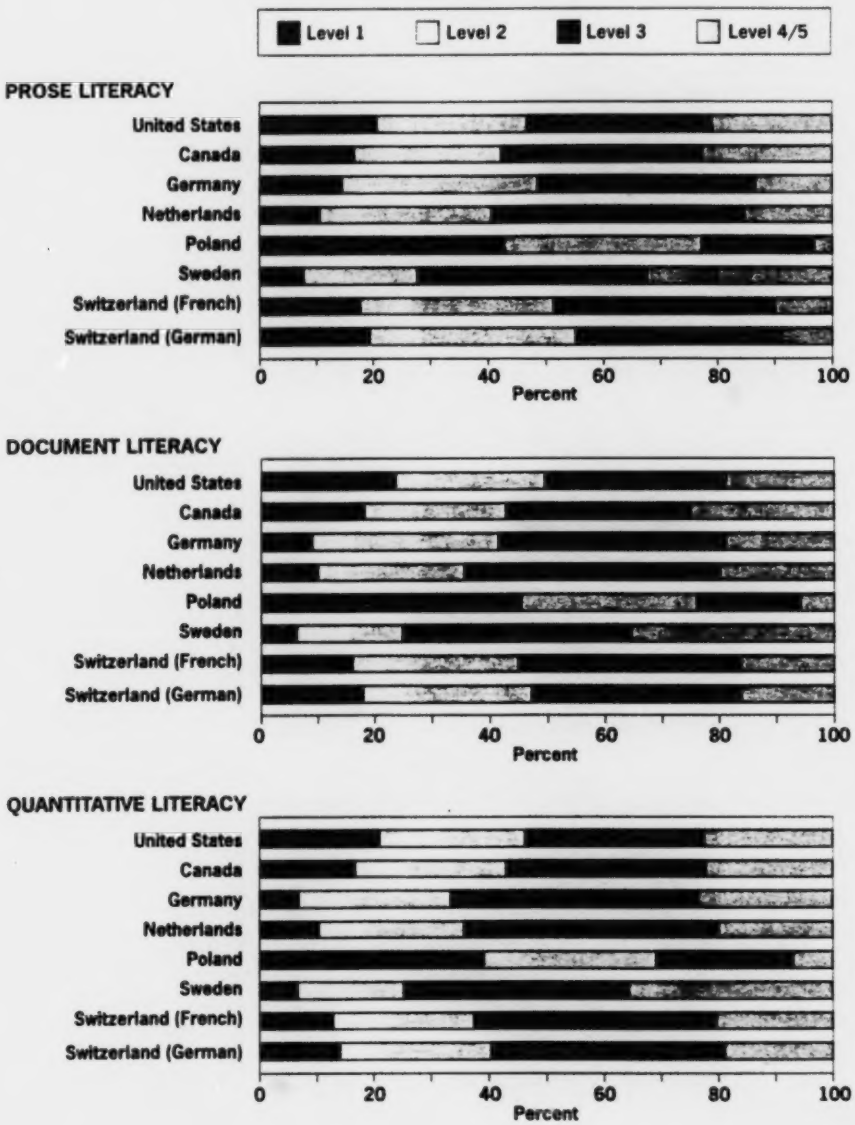

SOURCE: Organization for Economic Cooperation and Development and Statistics Canada, *Literacy, Economy and Society: Results of the First International Adult Literacy Survey*, 1995.

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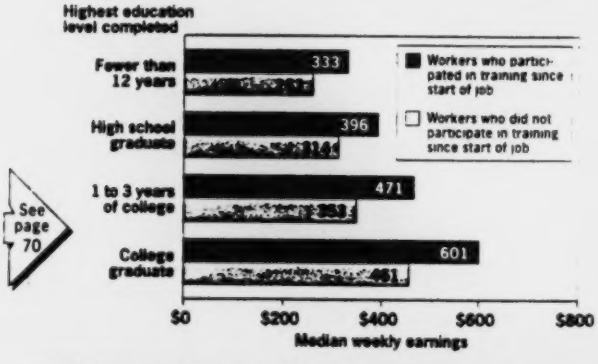
Training of Labor Force Participants

Workers usually complete their formal education before joining the labor force, but investment in human capital does not necessarily end at that time. Through training, many workers continue to improve their skills throughout their lives.

Workers who have participated in training while at their current job earn more than workers who have not participated in training.

Figure O
Median weekly earnings of full-time workers ages 16 years and older, by training status and educational attainment: January 1991



See page 70

NOTE: Includes only workers who needed no qualifying training for their current job.

SOURCE: Alan Eck, "Job-Related Education and Training: Their Impact on Earnings," *Monthly Labor Review* (October 1993): 21–38; U.S. Department of Commerce, Bureau of the Census, Current Population Survey, January 1991.

Within broad categories of educational attainment, median earnings in 1991 were higher for workers who participated in training to improve their skills while at their current job than for those workers who did not (figure O). Median weekly earnings were higher for trainees than for nontrainees in each of the educational attainment categories. Studies that examine direct measures of productivity confirm that formal training also has a positive effect on productivity.

Training participation has increased in recent years, and it is most prevalent among more highly educated workers and workers in highly skilled occupations.

An estimated 41 percent of the U.S. work force in 1991 had received skill improvement training on their current job, up from 35 percent in 1983 (figure P). Training is positively associated with education—61 percent of workers with a college degree in 1991 had participated in training on their current job, compared with 29 percent of workers with a high school degree or less and 46 percent of workers with some college. Training also appears to be more common among workers in highly skilled occupations, including managerial, professional, and technical workers. Workers in these occupations in 1991 had training rates of more than 50 percent. In contrast, no other occupation had a training rate of more than 40 percent at that time.

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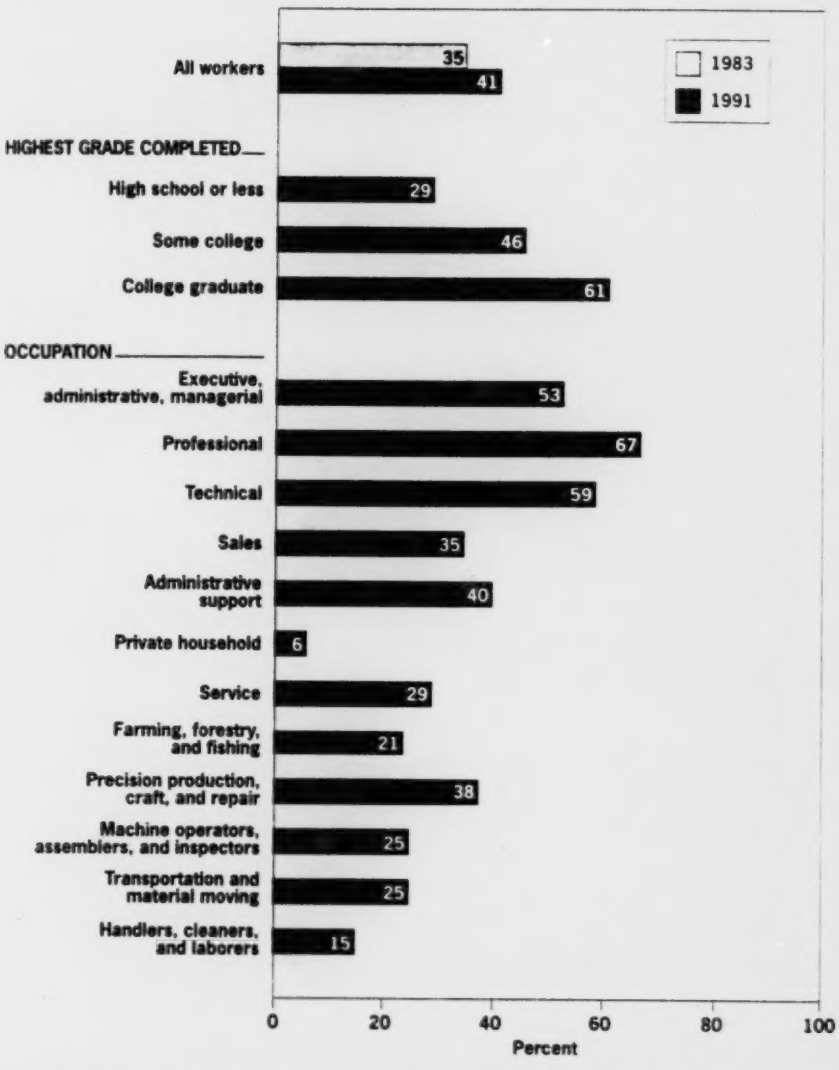
Figure P
All workers ages 16 years and older who participated in skill improvement training while on their current jobs, by education and occupation: 1983 and 1991
(percentage of workers in each category)

See pages 75–76



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *How Workers Get Their Training: A 1991 Update*, 1992; U.S. Department of Commerce, Bureau of the Census, Current Population Survey, January 1983 and 1991.

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SUMMARY

Workers in the United States are still more productive, on average, than workers in any other country. However, worker productivity in several industrialized countries is gradually catching up to that in the United States, and eventually the United States is likely to share the lead in worker productivity. This convergence in productivity is attributable, in part, to the rapid expansion of education in other countries. The education of the work force, according to at least some measures that contribute to economic success, is growing more rapidly in other countries than in the United States. But education is not the only determinant of worker productivity, and other factors no doubt have also played important roles in the rapid productivity growth in other countries.

Although the United States leads almost every other industrialized country in college attainment, and the academic achievement of U.S. students has been improving in recent years, U.S. students still tend to lag behind students in other countries with respect to some measures of achievement. In particular, the mathematics and science scores of U.S. students, especially older students, are lower than those of their counterparts in other industrialized countries. U.S. students do, however, perform relatively well on reading tests. Adults in the United States may not be as skilled in some areas as their counterparts in other countries. Compared to other countries that have tested literacy, the United States has a higher concentration of adults who score at the lowest literacy levels.

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CHAPTER 1

Introduction

Policymakers are concerned about the ability of American businesses and workers to compete in an increasingly international marketplace. Some observers assert that the growth in worker productivity in the United States has slowed significantly in the past two decades and that workers in other countries are achieving productivity levels similar to or greater than those of American workers. They attribute this alleged loss of competitiveness to deficiencies in the U.S. educational system in providing students with the skills necessary for success in the modern labor market. Such deficiencies in education, they argue, would harm entrants to the labor force by jeopardizing their ability to attain a relatively high standard of living. Employers also would suffer, as they would face shortages of skilled labor, which would jeopardize their ability to sustain competitive productivity levels.

This report presents a series of indicators related to productivity and education. The objective in developing these indicators is to shed some light on the debate about worker productivity in the United States and its relationship with the current condition of education. The indicators provide information at both the national and individual levels. At the national level, we examine labor force trends in productivity, earnings, and education, and compare the trends in the United States with trends in other countries. At the individual level, we examine the link between education and individual labor market outcomes, including employment, productivity, and earnings. In addition to the indicators, we discuss issues related to them. Our objective is to further interpret the indicators and to evaluate the research findings related to them. Throughout this report, the discussions are presented as separate sections that follow the indicator(s) to which they correspond. The placement of the discussion sections depends on the issues addressed in the indicators. Some indicators are followed by more than one discussion section, while other indicators are followed by no discussion section if none of the discussion sections is related to those indicators. The data used to create the figures presented in this report are available from the NCES World Wide Web site (http://www.ed.gov/NCES/) or by request from NCES (see the back of the title page for specific contact information).

The fundamental limitation in any study of worker productivity is that productivity is rarely observed directly. Measuring the link between education and worker productivity, either at the national level or at the individual level, usually depends

on using earnings to represent productivity. This approach is based on economic theory, which asserts that employers pay workers a wage that is equal to their marginal productivity. Many researchers have criticized the use of earnings to represent productivity, arguing that, for a variety of reasons, workers may not necessarily be paid an amount that reflects their marginal productivity at a given time. If this is true, the estimated relationship between education and wages would not accurately represent the relationship between education and productivity.

Like productivity, education can also be difficult to measure. Recognizing the limitations of any single measure of education, this report explores the link between economic productivity and three different measures of education: educational attainment, scores on academic achievement tests, and scores on adult literacy tests. Not only can attainment approximate the knowledge or skills that a person brings to the work force, but the academic degrees that reflect attainment may serve as requisite credentials for particular jobs. Consequently, there is reason to expect a relationship between a worker's educational attainment and the wage that he or she is paid. However, it cannot necessarily be assumed that attainment is an accurate indicator of the knowledge or skills that are brought to a job. Workers with similar educational attainment may be paid different wages because they have different skills or knowledge.

Given this possibility, the analysis is extended to a second type of education measure: scores on academic achievement tests. Admittedly, the use of test scores to measure achievement is not ideal because of the limitations of assessment technology as well as the uncertainty associated with the relationship between academic achievement and workplace skills. Nevertheless, test scores do provide some indication of educational success enjoyed by individuals, both in general and in specific subjects. Finally, recent research suggests that literacy in reading, writing, and basic quantitative and computing skills may be among the most important qualities that an individual brings to the workplace. This report uses scores on tests of adult literacy as a third measure of education.

The limitations in measuring productivity and education, together with other limitations that are discussed in this report, dictate that the indicators cannot be used to draw definitive conclusions about the competitiveness of firms hiring U.S. workers and the link between productivity and education. Rather, the indicators represent an initial effort to gather information about a broad set of outcomes and trends that are related to the ways in which education translates into worker productivity. One goal of this report is to demonstrate how the available data can be used to inform these issues and to show how additional data may be useful for future efforts to study these issues.

CHAPTER 2

Worker Productivity and Education

Worker productivity is affected by many factors, including the education and skill level of the work force. Education and skills are important because they expand a worker's capacity to perform a task or to use productive technologies. More educated workers are also usually better able to adapt to new tasks or to changes in their old tasks. Furthermore, because education enhances workers' ability to communicate with and understand their co-workers, it may prepare people to work in teams more effectively.

Some observers fear that the American educational system has deteriorated in comparison with the educational systems in other countries, and that this deterioration may soon cause the productivity of U.S. workers to lag behind that of workers in other countries. These observers have agreed that lagging productivity jeopardizes the nation's competitiveness in international markets and would eventually translate into a lower standard of living relative to other countries. But others argue that the relative economic performance and standards of living should not be the sole focus of studies of economic well-being in the United States. Although economic trends outside the United States can be used as a benchmark for gauging U.S. progress, continued and substantial improvements in U.S. productivity and standard of living can be maintained regardless of our position compared with other countries. This point does not, however, discount the importance of education. If educational deterioration causes productivity to slow or even to decline, it would have a negative impact on our standard of living.

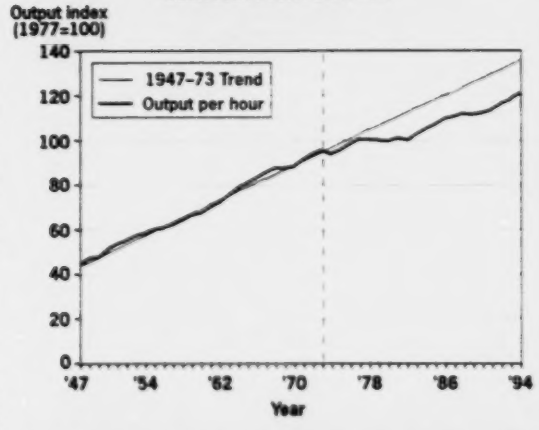
This chapter begins our investigation of education and worker productivity by examining recent trends in U.S. worker productivity. We extend this analysis of productivity by comparing it with the productivity in other industrialized countries and examining the extent to which American economic leadership is threatened by these other countries.

INDICATOR 1

Trends in U.S. Worker Productivity

Research on the productivity of U.S. workers has focused on trends in the growth of productivity in the post-World War II period. Worker productivity is typically measured by dividing output by the number of workers or the number of hours worked. Figure 2.1 shows the postwar trend in worker productivity as measured by business sector output per hour worked. Output per hour has increased nearly continuously over the postwar period. Decreases were generally confined to single-year fluctuations. Output per hour in 1994 was about three times the output per hour in 1947. The average annual rate of productivity growth from 1947 through 1994 was 2.1 percent.

Figure 2.1
Index of real output per hour of all persons, business sector: 1947–94



NOTE: Figures for years after 1988 were originally based on 1982=100. They were multiplied by a factor of 1.013 for use in the 1977=100 index. Hours of all persons include hours of employees, proprietors, and unpaid family workers. Output is the constant-dollar market value of final goods and services produced. For the businessector, the index relates to gross domestic produce (GDP) less general government,output of nonprofit institutions, output of paid employees of private households, andrental value of owner-occupied dwellings. Business output was about 78 percent of GDP in 1992.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics*, Washington, DC: U.S. Government Printing Office, 1989; *Monthly Labor Review 18 (8)* (August 1995): 175.

Concern about the trend in U.S. productivity is based primarily on the lower rate of productivity growth since 1973 as compared with the period from 1947 through 1973. It is clear that the growth in output per hour worked since 1973 has lagged behind the 1947–73 trend, as shown in figure 2.1. From 1947 through 1973, output per hour worked increased by an average of nearly 3 percent per year, compared with slightly more than 1 percent per year from 1973 through 1994. In recent years, slow productivity growth has especially been a problem in nonmanufacturing sectors of the economy, which represent an increasing share of total U.S. employment.[1] Because of the slowdown in labor productivity, growth in worker compensation (earnings plus

[1] Baily and Gordon (1988) show that output per hour of work increased by 2.52 percent per year in manufacturing from 1973 through 1987, compared with an increase of only 0.25 percent per year in nonmanufacturing. However, measuring productivity in nonmanufacturing can be difficult because changes in the quality of goods and services can be difficult to track in this sector. Problems in measuring productivity are discussed in detail later in this chapter.

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benefits) has slowed by a similar magnitude (Bosworth and Perry 1994). Given the strong connection between productivity and compensation, the productivity slowdown has been described by Baily and Gordon (1988) as "America's greatest economic problem."

Despite a vast amount of research on trends in productivity, economists remain perplexed about the nature of the post-1973 productivity slowdown. Various researchers attribute the slowdown to sectoral shifts in the labor force, inadequate accumulation of physical capital, inadequate work force training, or overemphasis on short-term goals in business management.[2] However, none of the studies has isolated the specific determinants of the post-1973 productivity slowdown.

Bishop (1989) argues that declines in education achievement, as measured by test scores, play an important role in the slowdown of productivity growth since 1973. On the basis of estimated returns to test scores and the historical trends in test scores and economic productivity, Bishop claims that declines in test scores since 1967 reduced the contribution of education to productivity by 0.05 to 0.12 percentage points per year from 1973 through 1987.[3] Although this estimated impact appears to be small, Bishop argues that it translates into substantial social costs. He sets the social cost in terms of foregone national product at $86 billion in 1987, and he projects that it will double from 1987 through 2004.

Although low academic achievement may inhibit the growth in productivity, it cannot account for the majority of the slowdown in U.S. productivity since 1973. First, the decline in productivity growth occurred all at once—too quickly to be attributed to slow-moving changes in work force quality. Second, the magnitude of the slowdown is much larger than the impact of dropping test scores cited by Bishop. Bishop's estimate would explain less than 10 percent of the overall productivity slowdown. Third, as is shown later in this chapter, productivity grew more slowly after 1973 in all industrialized countries, not just in the United States. It would be difficult to believe that the quality of education declined simultaneously in all industrialized countries beginning in 1973. Finally, Bishop's argument applies exclusively to the cohort of students educated in the late 1960s and 1970s. As is shown in chapter 4, the levels of achievement of U.S. students in the late 1980s were restored to the levels of the early 1970s.

---

[2]Baily, Burtless, and Litan (1993) discuss each of these possibilities.

[3]Bishop (1989) estimates the impact of academic achievement on individual productivity by estimating the relationship between earnings as a proxy for productivity and test scores as a proxy for achievement. The achievement proxy is constructed based on the responses to the 13 questions from the Lorge-Thorndike intelligence test, part of the Panel Study of Income Dynamics survey. Bishop then measures trends in academic achievement over time on the basis of scores on the Iowa Test of Educational Development. These trends are translated into changes in labor quality and linked to productivity in a growth-accounting framework.

Another possible explanation for the productivity slowdown is that measurement errors have caused observers to overestimate the magnitude of the slowdown. Researchers have paid particular attention to the accuracy of the price indices that are used in the calculation of real output. In the U.S. economy, there is a general trend that shifts away from standardized commodities with easily definable characteristics that change little over time toward goods and services for which issues of quality are of primary importance. Some argue that the complexity in defining quality as it pertains to modern goods and services makes it extremely difficult to disentangle pure increases in the price paid for the same quality goods from price increases that reflect changes in quality. If the trend in prices is mismeasured, trends in output and productivity will also be mismeasured. While this argument is appealing, a detailed study (Baily and Gordon 1988) of the empirical evidence suggests that errors in measuring output fail to explain the majority of the observed post-1973 productivity slowdown.[4]

A final possible explanation for the slowdown is that the lower rate of growth in productivity after 1973 may simply represent a return to the long-run trend in productivity, and that the high growth rate from 1947 through 1973 was a historical aberration (Baumol, Blackman, and Wolff 1989). The annual growth rate in output per hour for the entire period shown in figure 2.1, 1947–94, is approximately equal to the long-run productivity growth rate of 2 percent that has prevailed in the United States since 1870.[5] While these findings do not guarantee that the U.S. economy will return to and sustain 2 percent productivity growth in the future, they still do not conclusively show that productivity in the United States has already declined to a slower long-run growth rate. Rather, recent trends may be attributable to a short-run variation around an unchanged long-run trend.[6]

---

[4]Baily and Gordon (1988) estimate that errors in measurement explain, at most, 0.5 percentage points of the 1.5 point slowdown in productivity growth between 1948 and 1973 and 1973 and 1987. The majority, 0.3 percentage points, of this errors-in-measurement estimate is attributed to declines in the quality of labor, such as the decline in test scores documented by Bishop (1989), rather than to previously overlooked or mismeasured increases in the quality of goods and services. However, Baily and Gordon (1988) also present estimates from other studies, which suggest that the actual contribution of the decline in labor quality may be smaller than 0.3 percentage points.

[5]Maddison (1982) presents statistics showing that GDP per man-hour grew by an annual average compound rate of 2.3 percent from 1870 through 1979.

[6]Darby (1984) supports the argument that the statistics do not provide evidence of a long-run decline in productivity growth in the United States. Nordhaus (1982) points out that two similar periods of stagnancy in U.S. productivity occurred in this century. He presents statistics showing that U.S. productivity did not grow from 1901 through 1917 and grew slowly from 1924 through 1937.

INDICATOR 2

Productivity Trends in Industrialized Countries

Alarm about the recent slowdown in productivity in the United States is driven by the fear that other countries will surpass the United States in productivity, thereby achieving a higher standard of living at the expense of U.S. workers. While the available evidence is unclear as to whether the post-1973 U.S. productivity slowdown represents a long-term slowdown, it is clear that productivity in other countries is catching up to that of the United States. Figure 2.2 shows real gross domestic product (GDP) per worker for the "group of seven" (G-7) industrialized countries. The United States has clearly been the world leader in productivity for many years. During the postwar period, however, the other industrialized countries are catching up to the United States because they have increased productivity at a faster rate than the United States.

Despite the fact that other countries are gaining on the United States in productivity, the United States is still the world leader in productivity, and the trends do not necessarily signal a significant decline in U.S. economic capabilities. As of 1990, the United States was still the leader in productivity among the G-7 countries. GDP per worker was slightly higher than in Canada and about 25 percent higher than in Italy (the country with the third highest GDP per worker) (figure 2.2). Furthermore, other countries are not positioned to surpass the United States in the next few years; rather, they have been slowly catching up over many decades. Alternative data on productivity presented in table 2.1 show that this phenomenon, which is not new, actually began shortly after the end of World War II as other countries experienced higher growth rates than the United States from 1950 through 1973.[7]

Figure 2.2
Real GDP per worker in G-7 nations: 1950-90
(in thousands of dollars based on 1985 international prices)

SOURCE: Penn World Table (Mark 5.6), distributed by the National Bureau of Economic Research. For a description, see Robert Summers and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," Quarterly Journal of Economics (May 1991): 327-368.

[7] The data presented in table 2.1 and figure 2.2 are from different sources and are based on different productivity measures—productivity is measured as GDP per worker in figure 2.2 and GDP per hour worked in table 2.1.

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Table 2.1
Growth in gross domestic product per hour worked (average annual growth rate)

	I 1913–1950	II 1950–1973	III 1973–1984	Acceleration from I to II	Slowdown from II to III
France	2.0	5.1	3.4	+3.1	-1.7
Germany	1.0	6.0	3.0	+5.0	-3.0
Japan	1.7	7.7	3.2	+6.0	-4.5
Netherlands	1.7	4.4	1.9	+2.7	-2.5
United Kingdom	1.6	3.2	2.4	+1.6	-0.8
United States	2.4	2.5	1.0	+0.1	-1.5

SOURCE: Angus Maddison, "Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment," *Journal of Economic Literature* (June 1987): 649–698.

The data also indicate that the pattern of growth in productivity that occurred in the United States in the post-World War II period also occurred in the other industrialized countries. As shown in table 2.1, productivity grew at an accelerated rate in these countries from 1950 through 1973, compared with the period from 1913 through 1950. The slowdown in the growth of productivity that occurred in the United States in the early 1970s appears also to have occurred in the other industrialized countries. The percentage-point magnitude of the decline was largest in Japan (4.5 percentage points) and smallest in the United Kingdom (0.8 percentage points). The decline in productivity in the United States (1.5 percentage points) was between these two extremes.

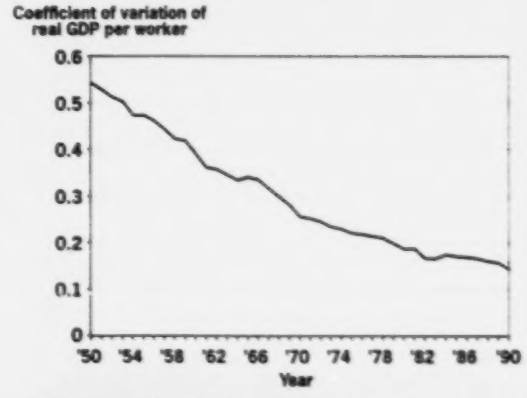
The productivity trends in figure 2.2 and table 2.1 appear to be consistent with the economic hypothesis that productivity levels in countries with broadly similar labor resources will converge over time.[8] When the productivity of one country is superior to that of a number of other countries, largely as a result of differences in technical knowledge, the "follower" countries can catch up to the leader by acquiring new technical knowledge from the leader. Productivity converges because countries eventually learn these new productive techniques through trade, technology transfer, and their own research and development efforts. Figure 2.3, which shows that the coefficient of variation in productivity in the G–7 countries has declined steadily since 1950, demonstrates that productivity in these countries is, in fact, converging.[9]

[8]Baumol, Blackman, and Wolff (1989) provide a detailed description and analysis of this hypothesis.

[9]The coefficient of variation is equal to the standard deviation of productivity divided by the mean.

According to the convergence hypothesis, followers can eventually turn their technological disadvantage into faster growth. Although all countries benefit from technology transfer, the follower countries have more to learn from the leader than the leader has to learn from them. For the follower countries, this greater learning opportunity speeds up the increases in productivity, and these "stepped-up" increases cause the followers to begin to catch up to the leader. The process continues as long as the follower countries have a lot to learn from the leader. As the gap in technical knowledge between the countries narrows, the relative growth benefits of technological disadvantage tend to disappear and convergence may slow. Evidence presented in Van Ark and Pilat (1993) is consistent with this theory. They show that prior to 1980, Germany and Japan converged rapidly on the United States, and by the early 1980s, Germany and Japan had achieved an overall productivity level in manufacturing close to that of the United States. But from 1980 through 1990, the rate at which Germany and Japan gained on the United States slowed substantially.

Figure 2.3
Convergence of real GDP per worker among the G-7 nations: 1950–90



NOTE: The coefficient of variation is equal to the standard deviation of productivity divided by the mean.

SOURCE: Penn World Table (Mark 5.6), distributed by the National Bureau of Economic Research. For a description, see Robert Summers and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–1988," Quarterly Journal of Economics (May 1991): 327–368.

Productivity convergence can be a slow process. The convergence among industrialized countries appears to have begun more than 100 years ago (Baumol, Blackman, and Wolff 1989; Maddison 1987). The ability of the United States to maintain a substantial lead in productivity for so long is partly attributable to the two world wars, which destroyed the productive capacities of other countries while spurring technical innovation in U.S. manufacturing. Barring similar catastrophes, it is likely that the United States will eventually share the lead in worker productivity with other industrialized countries. Because technology can readily be transferred back to the United States, it is unlikely that the United States will fall far behind the other countries unless it loses the capability to utilize new technologies efficiently.

While the transfer of production technology from leader to followers is the primary factor that underlies the convergence hypothesis, other factors also play major roles in determining productivity. Increases in the educational attainment of the work force, which we discuss in the following section, is one important factor. Investment in physical capital is another. The exact relationship between

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investment in capital and the convergence hypothesis is unclear, but the former is highly correlated with productivity. A study of productivity growth by the Bureau of Labor Statistics (1993) found that increases in capital intensity accounted for about 40 percent of productivity growth in the United States from 1948 through 1990.[10] Countries with the newest *and* the least obsolete capital tend to have higher productivity growth rates than other countries. The dwindling leadership position of the United States in the world economy is coincident with low growth in the rate of capital accumulation and the relative aging of its stock of capital (Wolff 1991). In the early 1960s when the United States was the dominant economy in the world, the nation had a much higher capital-labor ratio than other industrialized countries. Since then, the other countries that converged with the United States in terms of productivity have accumulated capital at a faster rate than the United States. By 1979, the U.S. capital stock was 15 percent older than the average for four other industrialized countries[11] and 73 percent older than Japan's. The rate at which other countries have caught up to the United States with respect to productivity is positively associated with the rate of growth of the capital-labor ratios in those countries.

DISCUSSION: CONTRIBUTION OF EDUCATION TO ECONOMIC PRODUCTIVITY

Economic research based on growth-accounting methods has shown that education has made a major contribution to growth in U.S. economic productivity.[12] Denison (1979) estimated that education contributed about 20 percent of the growth in national income per person from 1948 through 1973. Using similar methods and data for the same period, Jorgenson (1984) estimated that education accounted for 38 percent of the total labor contribution to U.S. output growth, or about 11 percent of growth overall. Recent estimates for the period from 1973 through 1984 (Sturm 1993) suggest that education accounted for about 15 percent of the growth in output per hour worked over this period. A more comprehensive study of productivity from 1948 through 1990 using growth accounting (U.S. Department of Labor 1993) showed that during this period, rising levels of educational attainment were responsible for about 14 percent of the growth in output per hour worked in the private sector.

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[10] According to the U.S. Department of Labor (1993), increases in capital intensity accounted for an estimated 0.9 percent points of the 2.2 percentage point per year increase in output per hour in private nonfarm business from 1948 through 1990.

[11] This group of countries includes Germany, Italy, Japan, and the United Kingdom.

[12] In growth accounting, researchers attribute growth in output to changes in factor inputs, such as capital and labor. The relative value of different levels of education attainment in the growth accounts is determined by the earnings of workers with different levels of attainment.

The growth-accounting methods used in these studies have been frequently criticized. First, they use variation in earnings to represent variation in productivity, which cannot be observed directly. The relative productivity contributions of different levels of educational attainment are set according to earnings differentials among educational groups. If earnings are not closely correlated with productivity, this approach is inappropriate. The use of earnings differentials to measure the effect of educational attainment on productivity is discussed in chapter 3.

Second, growth-accounting methods are used to "capture" the direct effect of different growth factors, but they do not account for interaction among the factors. Many researchers have discussed the importance of interaction, such as that between education and new technology. For example, a country's ability to exploit new technologies may depend on workers who have the education necessary to use the new technologies effectively. Third, growth-accounting methods focus exclusively on changes in years of formal education to measure the contribution of education. They do not control either for changes in the quality of education or for the contribution of informal education or training.

Despite the weaknesses of growth-accounting methods, they have provided the best available estimates of the contribution of education to productivity growth. Although the exact magnitude of the contribution may be unclear, studies consistently show that education makes a substantial contribution to productivity growth. Recent attempts to generate estimates that are not subject to the traditional criticisms of growth-accounting methods support this conclusion. Kim and Lau (1992) use a new methodology called the "meta-production function" approach to estimate the relationship between aggregate output and inputs.[13] They estimate that education accounted for 11 percent of the growth in aggregate real output from 1948 through 1985.

International evidence suggests that education plays a similarly important role in influencing productivity in other countries as it does in the United States. Sturm (1993) demonstrates that among a select group of industrialized countries, the contribution of education to economic growth from 1973 through 1984 was the highest in France (22 percent) and the lowest in Germany (4 percent).[14] Using methods as well as a sample period different from those of Sturm (1993), Kim and Lau (1992) show that the contribution of education to growth in five industrialized countries from 1957 through 1985 was between 11 percent and 27 percent, depending on the

[13]The assumption of a meta-production function implies that the same production function can be used to characterize productivity in different countries. Kim and Lau use the meta-production function to perform an alternative growth accounting that dispenses with the traditional assumptions of constant returns to scale, neutrality of technical progress, and profit maximization. (Boskin and Lau (1990) describe the alternative growth-accounting procedure.)

[14]According to the estimates presented in Sturm (1993), the percentage of the growth rate explained by education is 15.5 percent in the United States, 22.0 percent in France, 20.9 percent in the Netherlands, 18.9 percent in the United Kingdom, and 10.8 percent in Japan.

country. The lowest impact was 11 percent in the United States and Japan, and the highest impact was 27 percent in West Germany.[15] Overall, the estimates suggest that the extent to which education has contributed to productivity growth in the United States is generally the same as in other industrialized countries. Therefore, the data provide no indication that the contribution of education to growth in the United States lags behind the contribution of education to growth in other countries.

Evidence related to the convergence hypothesis also suggests that education plays an important role in productivity. Baumol, Blackman, and Wolff (1989) find that different groups of countries are converging to different productivity levels according to their educational levels. The industrialized countries with the highest educational levels are converging to the highest productivity levels. Other countries are converging to lower levels—countries with roughly comparable educational levels are converging to a similar level, but they are not closing the gap with countries at higher educational levels.[16] Supporting evidence about the importance of education in productivity convergence is presented in Barro (1991), who shows that countries with low per capita GDP but relatively high levels of schooling tend to catch up to the GDP leaders.[17]

These findings suggest that countries that lag in productivity must have some minimum level of education to be able to catch up to the leaders in productivity.[18] Regression estimates presented in Baumol, Blackman, and Wolff (1989), which are based on a broad cross-section of countries, suggest that high school education is especially important in helping a country absorb and use new production technologies. Based on these estimates, Baumol, Blackman, and Wolff (1989) argue that primary education alone may not prepare the work force to adopt and implement new technologies. At the same time, findings on higher education appear to indicate that it may be less important than high school education in the productivity "catch-up" process for the broad cross-section of countries. However, higher education may still be a critical determinant of the relative productivity levels among the most industrialized countries.

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[15]The impact of education on growth in the other two countries was 19 percent in France and 24 percent in the United Kingdom. The difference between the Kim and Lau (1992) estimate and the Sturm (1993) estimate for Germany is striking. Because the two studies use different data, different estimation methods, and different (though overlapping) time periods, it is difficult to determine what causes this difference.

[16]Baumol, Blackman, and Wolff (1989) estimate the impact of education on productivity using cross-section data from the Penn World Table (Summers and Heston 1991). Their findings show that enrollment rates for primary, secondary, and higher education have significant positive impacts on productivity growth. Controlling for enrollment rates, countries tend to converge on the productivity leader over time.

[17]Barro (1991) examines data on a cross-section of 98 countries from 1960 through 1985. Based on these data, Barro shows that the growth rate of real per capita GDP over the observation period is positively related to the school enrollment rates in 1960 and negatively related to the 1960 level of real per capita GDP.

[18]Kyriacou (1991) also presents findings that suggest productivity convergence occurs only if sufficient levels of schooling among the labor force have been accumulated.

CONCLUSIONS

Indicators on productivity, together with the existing research, lead to the following conclusions:

- ***Worker productivity in the United States has grown nearly continuously since the end of World War II. Decreases in productivity have been limited to single-year fluctuations.***

- ***Postwar growth in U.S. productivity was slower after 1973 than it was before 1973. Researchers have not yet discovered an adequate explanation for this slowdown in productivity growth. But the growth rate prior to 1973 was high by historical standards, so an eventual decline in the growth rate might be expected. The historical data therefore suggest that the post-1973 decline may just represent fluctuation around a long-run trend.***

- ***Worker productivity in other industrialized countries has increased at a faster rate than in the United States; therefore, these countries are slowly catching up to the United States. This process is not a new phenomenon. The latest phase of convergence began just after World War II, many years prior to the slowdown in productivity that occurred in the United States after 1973. Similar to the United States, the other industrialized countries experienced slower growth in productivity after 1973 than before 1973. The convergence hypothesis together with the trends in productivity growth suggest that the United States is likely to eventually share the lead in productivity with other industrialized countries. However, the convergence hypothesis also implies that the United States is unlikely to fall far behind any other country in terms of worker productivity.***

- ***Growth in education appears to be a substantial contributor to productivity growth, accounting for an estimated 11 to 20 percent of growth in U.S. productivity in recent decades. For other countries, convergence to the U.S. productivity level appears to depend on a minimum level of education, especially secondary education, prevailing among the work force.***

- ***Factors other than education are important to productivity. The most prominent example is investment in physical capital. One study suggests that increases in capital intensity accounted for about 40 percent of U.S. productivity growth in recent decades. Other countries that have increased worker productivity faster than the United States have also invested in physical capital at a faster rate than the United States. Those countries with the highest capital-labor ratios have been catching up to the United States at the fastest rate.***

CHAPTER 3

Economic Consequences of Educational Attainment

While it is possible to link trends in worker productivity at the national level to changes in education at the national level, increases in worker productivity at the national level occur as conditions in the economy, including education, change to make individual workers more productive. In this chapter, we focus on the economic consequences of education at the individual level in an attempt to measure the economic value of educational attainment and the incentive for individuals to invest in education.

As discussed in the previous chapter, estimates of the contribution of educational attainment to worker productivity at the national level are based on the observed average earnings of workers at different education levels. Researchers characterize the differences in earnings by level of education as the return to the investment in human capital that is inherent in the acquisition of more education.[19] The returns as measured by earnings differences are used to represent the impact of education on worker productivity. This approach is based on economic theory, which states that in a competitive labor market, a worker's wage rate will be equal to his or her marginal productivity. Education may also improve a worker's long-term productivity because it increases his or her employment stability, thereby minimizing periods of unemployment in which the worker is not productive.

In this chapter, we consider the trends in the economic returns to education as measured by differences in unemployment and earnings. We acknowledge the possibility that differences among workers in unemployment and earnings may not closely mirror differences in productivity.[20] But even if the estimated returns are not an accurate representation of the effects of education on productivity, the estimates still provide measures of the economic incentives for further education, and we can examine how these incentives have changed over time.

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[19]Alternative theories to human capital theory assert that additional education does not increase productivity, but rather that it is valuable for sorting out individuals with inherently low or high abilities or aptitudes. Even in this theory, additional education represents a potentially valuable investment from the worker's perspective because education is a signal that the worker has high ability and the potential to be highly productive.

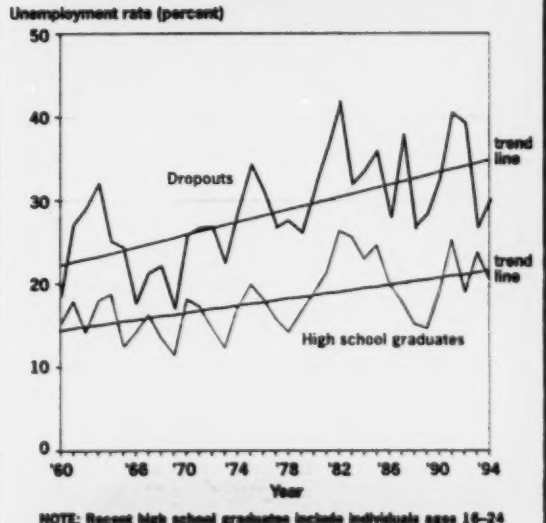
[20]Several theories of employment contracts have attempted to explain why workers or employers may prefer contracts that offer only modest adjustments of wages in response to differences in worker productivity. For example, employment contracts that limit wage adjustments may appeal to risk-averse workers who prefer a steady income. Use of such contracts implies that a worker's wage rate at a given point in time may not be equal to that worker's marginal productivity.

INDICATOR 3

Education Attainment and Unemployment

Students often have trouble moving from school to work. Of particular concern in the United States is the transition from high school to work. This transition may entail lost productivity if students are unable to find employment soon after they graduate from or drop out of school. The unemployment rate among those who have recently left school indicates just how difficult the transition can be.[21]

Figure 3.1
Unemployment rate of recent high school graduates and dropouts not enrolled in college: 1960–94



NOTE: Recent high school graduates include individuals ages 16–24 years who graduated during the survey year and were not enrolled in college. Recent high school dropouts include individuals ages 16–24 years who did not graduate and who were in school 12 months earlier, but who were not enrolled in the survey month.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*, and special tabulations; U.S. Department of Commerce, Bureau of the Census, October Current Population Surveys.

Over the past 30 years, a large proportion of school dropouts and high school graduates not enrolled in college were unemployed shortly after leaving school (figure 3.1). The transition from school to work appears to be tougher for dropouts than for graduates, as dropouts tend to have had a higher unemployment rate throughout most of the years shown in figure 3.1. For example, in 1994, 30 percent of dropouts compared with 20 percent of graduates were unemployed. This difference is an indication that there is a substantial economic penalty for not graduating from high school. The transition to work also appears to have become more difficult over time for some dropouts and high school graduates. The unemployment rates for both dropouts and graduates have generally increased since 1960, as shown by the trend lines in figure 3.1.

[21] Time spent unemployed following school can also have potentially positive implications for labor force entrants if they use the time to find the best possible match between their own skills and the needs of prospective employers.

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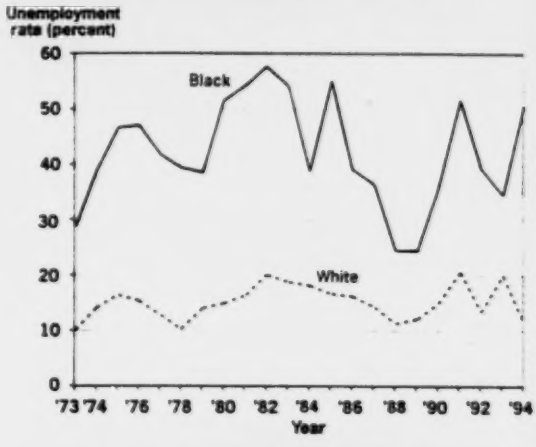
The unemployment rate for recent high school graduates and dropouts fluctuates in the short run in response to the business cycle, with recessions generating higher unemployment rates. For example, the most recent economic recession, beginning in 1990, had a substantial adverse impact on high school graduates and dropouts as they made the transition from school to work. Consequently, unemployment rates at least for graduates increased substantially between 1989 and 1991. Similar fluctuations occurred in response to previous recessions.

Figure 3.2
Unemployment rate of recent high school graduates not enrolled in college, by race: 1973–94



NOTE: Recent high school graduates include individuals ages 16–24 years who graduated during the survey year and were not enrolled in college.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*, and special tabulations; U.S. Department of Commerce, Bureau of the Census, October Current Population Surveys.

Blacks appear to face a much more difficult transition from high school to work than whites. Among graduates, the unemployment rate from 1973 through 1994 was generally higher for blacks than for whites (figure 3.2). Blacks were also affected significantly by economic conditions. In response to the latest recession, for example, the unemployment rate among black high school graduates doubled, from about 25 percent in 1989 to about 50 percent in 1991. While the unemployment rate for white graduates increased over the same period, the unemployment rate for whites remained substantially below the rate for blacks.

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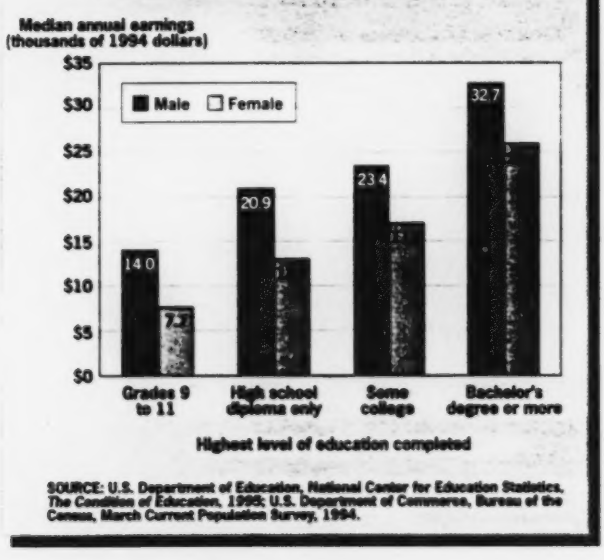
INDICATOR 4

Education Attainment and Earnings

Most of the research on the effect of education on economic outcomes has focused on how education affects earnings. The effect of education on earnings represents the private economic return to the investment in education. Education probably also generates social benefits that are not reflected in earnings. For example, increased education may reduce crime rates or the use of government assistance programs, thereby benefiting other members of society. While these effects may be important, they do not relate directly to economic productivity and are beyond the scope of this chapter.

Figure 3.3
Earnings for all wage and salary earners ages 25–34 years, by sex and educational attainment: 1993



SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*; U.S. Department of Commerce, Bureau of the Census, March Current Population Survey, 1994.

Data from the Current Population Survey demonstrate that median earnings increase with the level of schooling. Among males 25–34 years old in 1993, the median earnings of those with a college degree were approximately $33,000 per year, which was more than 50 percent greater than the median earnings of high school graduates and more than twice the earnings of high school dropouts (figure 3.3). A similar relationship between education and earnings held for females 25–34 years old, although for each educational category, the median earnings were lower for females than for males.

Estimates of the returns to education, holding other factors constant, also demonstrate the positive returns to education for young workers. According to these estimates, the returns to a college degree increased dramatically in the first half of the 1980s. Figure 3.4 shows that the earnings advantage for college graduates compared with that for high school dropouts increased from 56 percent from 1975 through 1980 to 84 percent from 1981 through 1986.[22] The returns to a high school

[22]These comparisons, which are from Murphy and Welch (1989), control for differences in race, sex, and age.

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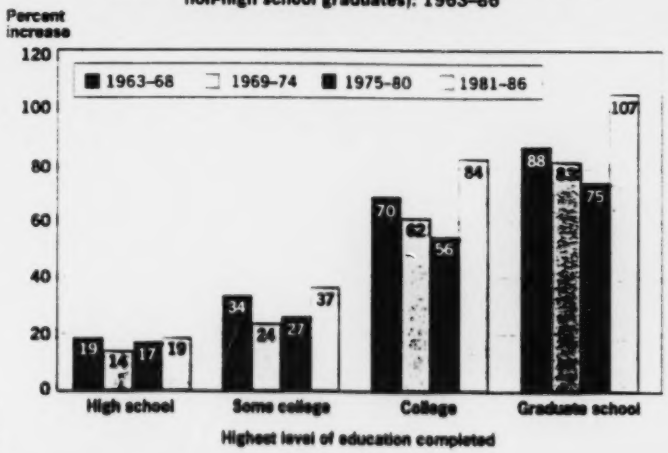
diploma also increased during the 1980s, but more modestly than for a college degree. Other things being equal, high school graduates earned 19 percent more than dropouts from 1981 through 1986, compared with 17 percent more from 1975 through 1980.

Figure 3.4
Estimated returns to education among workers with 1 to 5 years of work experience (percent increase over average wages of non-high school graduates): 1963–86



NOTE: Estimates of the returns to education control for differences between educational groups in race-ethnicity, age, and sex.

SOURCE: Kevin Murphy and Finis Welch, "Wage Premiums for College Graduates: Recent Growth and Possible Explanations," *Educational Researcher* (May 1989): 17–26; U.S. Department of Commerce, Bureau of the Census, March Current Population Surveys.

Increases in the returns to education were most dramatic at the highest levels of education. The increase in the returns to a high school diploma brought the rate of return back to the 19 percent that prevailed from 1963 through 1968, as shown in figure 3.4. But for higher levels of education, the rates of return in the 1980s exceeded those in earlier periods. The earnings advantage for each level of additional education compared with high school increased in the 1980s. For example, the returns shown in figure 3.4 for high school and college graduates imply that, compared with high school graduates, the earnings advantage for college graduates increased in the early 1980s, from 33 percent to 55 percent.[23]

The increase in returns to a college degree occurred as real wages increased among college graduates while real wages declined for high school graduates and dropouts.[24] Figure 3.5 shows that between 1980 and 1990 real income increased for men with four or more years of college and for women with one or more years of college. Real income decreased or remained approximately constant for groups with less education.

[23]These estimates are based on dividing one plus the return to college shown in figure 3.4 by one plus the return to high school.

[24]See Murphy and Welch (1989), Eck (1993), and Katz and Murphy (1992) for detailed discussions of the earnings trends by level of educational attainment.

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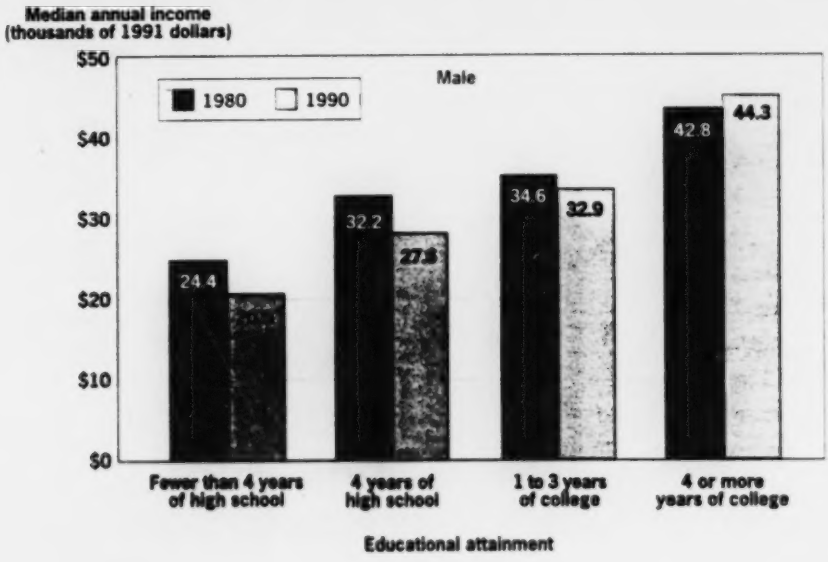
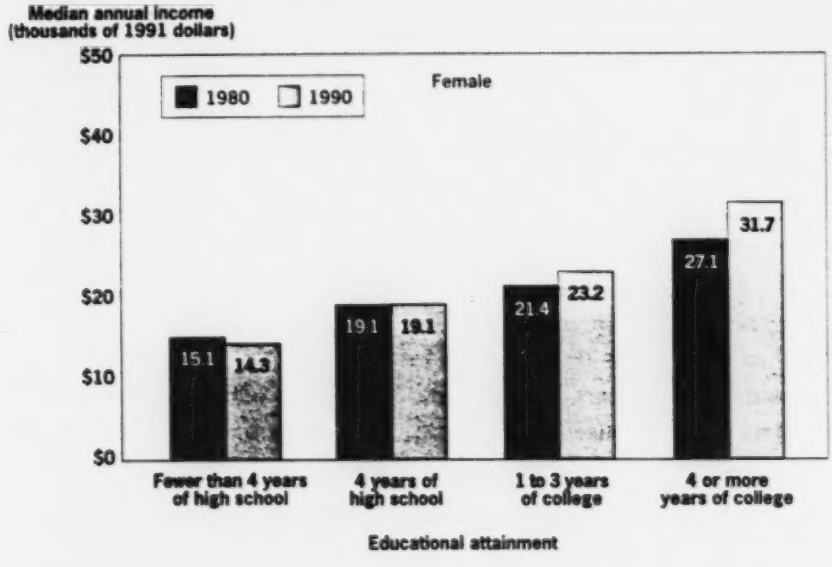
Figure 3.5
Median annual income for full-time workers ages 25 years and older, by sex and educational attainment: 1980 and 1990





SOURCE: Alan Eck, "Job-Related Education and Training: Their Impact on Earnings," *Monthly Labor Review* (October 1993): 21–38; U.S. Department of Commerce, Bureau of the Census, March Current Population Surveys.

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DISCUSSION: DETERMINANTS OF THE INCREASING RETURN TO EDUCATION

Recent research has attempted to identify the factors that influence the increase in the returns to education. Several labor demand and supply factors have been cited as important. On the demand side, there appears to have been a rise in technological factors favoring more highly educated workers with greater problem-solving skills, driving up their relative wages (Katz and Murphy 1992).[25] Recent research (Berman, Bound, and Griliches 1994) attributes much of the change in the wage structure of manufacturing to increased demand for high-skilled labor.[26] The introduction of new production labor-saving technology has also decreased the demand for lower-skilled workers in manufacturing, depriving them of traditionally high-paying jobs. An important factor in the increased demand for high-skilled labor may be the expansion of computer use. Estimates presented by Krueger (1993) suggest that between one-third and one-half of the increase in the rate of return to education can be attributed to expanded computer use.[27]

A number of supply-side factors have also contributed to the increased returns to education. First, the educational attainment of new labor force entrants leveled off after a period of rapid growth. For males, there was even a slight drop in the proportion of labor force entrants with education beyond high school. This decrease in the rate of growth of college graduates, combined with the demand changes discussed above, put upward pressure on wages paid to those who did graduate. At the same time, the influx of new immigrants, both legal

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[25]Using data from the Current Population Survey, Katz and Murphy (1992) show that the majority of the shift in relative demand for more highly educated workers occurred within industrial and occupational sectors. They conclude that these within-sector shifts are likely to reflect skill-biased technological changes.

[26]Berman, Bound, and Griliches (1994) use data for the period 1959 to 1989 from the Annual Survey of Manufactures, the Census of Manufactures, and the National Bureau of Economic Research trade data set. They base their conclusion about the importance of technological changes on three findings: (1) the shift in relative demand for more educated workers is due to increased use of nonproduction workers within 450 manufacturing industries rather than to a reallocation of employment among the industries; (2) international trade generated only minor shifts in employment away from production-labor-intensive industries; and (3) within-industry increases in the use of nonproduction workers are strongly correlated with investment in computers and research and development.

[27]Based on data from the Current Population Survey, Krueger (1993) estimates that workers who use a computer at their job earn 10 to 15 percent higher wages than other workers. Because of the high rate of computer use among highly educated workers and the expansion of computer use in the 1980s, the wage premium for computer use accounts for a substantial proportion of the increase in returns to education.

and illegal, increased the supply of less-educated workers. From 1975 through 1985, the percentage of high school dropouts who were immigrants increased from 17 to 31 percent (Borjas, Freeman, and Katz 1992). The impact of immigrants on average wages is further exacerbated if, as seems likely, the immigrants with less education face even greater barriers to employment than other Americans with a similar level of education. As a result of these barriers, immigrant workers are paid relatively low wages, which pulls down the average wage for the less-educated group even before accounting for the supply effect of the immigrants on relative wages.

Increased imports may also contribute to the effect of foreign labor supply because they create an indirect increase in the supply of less-educated labor from abroad. Economists disagree about the extent to which increased imports have affected wage differentials. Borjas, Freeman, and Katz (1992) estimate that growth in the U.S. trade deficit accounted for 15 to 25 percent of the rise in the college-high school wage differential from 1980 through 1985. Karoly and Klerman (1994) and Wood (1994) also argue that international trade has played a significant role in pushing down the relative wages of less-educated workers. In contrast, a recent detailed study of this effect (Lawrence and Slaughter 1993) argues that imports did not make an important contribution to changes in U.S. relative wages in the 1980s. They conclude, as have other researchers, that technological change rather than trade has been the primary factor driving down relative wages for production workers.

Another potential supply factor that may contribute to increasing returns to education is a change in the skill of labor force entrants with a given level of educational attainment. Specifically, researchers have pointed to a decline in the quality of U.S. elementary and secondary education as a contributor to the increase in returns for college education. According to this argument, high school graduates are paid less, both in real terms and compared with college graduates, because they are less skilled than high school graduates of previous years. There is evidence, however, to dispute this argument. Older high school graduates, who received their formal education before the alleged decline in U.S. education, suffered real wage declines similar to those of younger high school graduates (Blackburn, Bloom, and Freeman 1990).

The rising returns to education are not simply the product of increased earnings for better-educated workers. Rather, the data imply that less-educated workers are at greater risk of having difficulty in the labor market now than in the past, and that the increase in returns to education is caused in part by the decrease in real earnings for those with less schooling. Nevertheless, it is difficult to evaluate changes in average wages for separate education groups. Part of the change in wages by level of education is caused by the changing composition of the

groups. Hence, tracking the wages of an education group, like high school graduates, over time can be misleading because characteristics of high school graduates have changed over time.

Part of the change in the composition of the educational groups occurs naturally as the educational attainment of the population increases. For example, the number of college graduates increases as students who in previous years would have entered the labor market directly now go on to college instead. These students, on average, are likely to be the most able of the students who in the past did not attend college, but they are also likely to be less able than the students who would have previously gone to college.[28] Consequently, the movement of this group between educational categories can cause a decrease in average wages in both categories. The wages of high school graduates will decrease as the best students from the group move into the college group. At the same time, these students bring down the average wage of the college group if they are less able, on average, than the traditional college group. Of course, average wages for the entire population will still increase if the new college attendees earn more than if they had not attended college.

Trends in immigration have probably contributed to the compositional changes in the education groups. As immigrants become a larger proportion of the low-education groups, they probably drag down the average wage for these groups because they face significant obstacles to employment, such as language barriers or unfamiliarity with the U.S. labor market, and are forced to accept lower-paying jobs. But this wage decrease is not evidence of a decline in the economic standing of a particular educational group. Rather, the groups themselves have changed in significant ways that affect the group-specific average wages.

The increase in earnings inequality by education level has been accompanied by a general increase in income inequality in the United States. Income inequality may be harmful to the overall economy regardless of its source. Recent empirical research by Persson and Tabellini (1994) provides evidence that greater income inequality causes slower economic growth. Findings based on pooled historical data from a cross-section of nine developed countries demonstrate that differences in income distribution explain about one-fifth of the variance in growth rates across countries and over time.[29] None of the other variables tested by Persson and Tabellini (1994) explains more than one-tenth of the variation.

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[28]Baker and Smith (1994) report (based on data from the High School and Beyond Survey and the 1992 National Educational Longitudinal Study) that the percentage of high school seniors in the bottom quartile of academic performance who plan to go to college doubled from 1982 through 1992.

[29]The growth measure used by Persson and Tabellini (1994) is annual average growth rate of gross domestic product per capita.

The mechanism by which inequality slows economic growth is unclear. Persson and Tabellini (1994) argue that it is political. According to their theory, greater inequality leads to policies that increase tax rates on investment and other productive activities in order to redistribute income. As tax rates are increased, investment declines, which eventually causes productivity to slow down. Other researchers have argued that inequality slows growth through an economic mechanism. In this theory, increased income inequality makes it difficult for those at the bottom of the income distribution to acquire the skills necessary to succeed in the labor market. This may occur because poor families cannot borrow money to educate their children or because poor communities cannot effectively educate their children or provide them with role models. Employers, therefore, may face shortages of qualified workers, which can negatively affect production efficiency. Eventually, the overall economy is harmed by the lack of skills among the poor as companies become less productive and economic growth suffers.

DISCUSSION: ESTIMATED RETURNS BASED ON DIRECT MEASURES OF PRODUCTIVITY

The effect of education on earnings is typically used as a proxy for the effects of education on productivity. However, recent research has attempted to identify direct measures of productivity as a means of estimating the impact of education on productivity. Hellerstein, Neumark, and Troske (1994) estimate the impact of education on productivity using data from the Worker-Establishment Characteristics Database (WECD), which matches employer data from the Longitudinal Research Database with employee data from the 1990 Decennial Census. By combining individual worker data with data on the plants where workers are employed, the researchers compare relative wages of workers with their relative marginal productivities.

Findings based on the WECD data demonstrate that college attendance has a substantial impact on productivity. Moreover, the estimated impact of college attendance on productivity presented in Hellerstein, Neumark, and Troske (1994) is at least 23 percent higher than its estimated impact on wages. College-educated workers are paid 26 to 36 percent more than workers who have not attended college, but college-educated workers are also 51 to 75 percent more productive. These findings imply that college-educated workers are only partially compensated for their increased productivity.

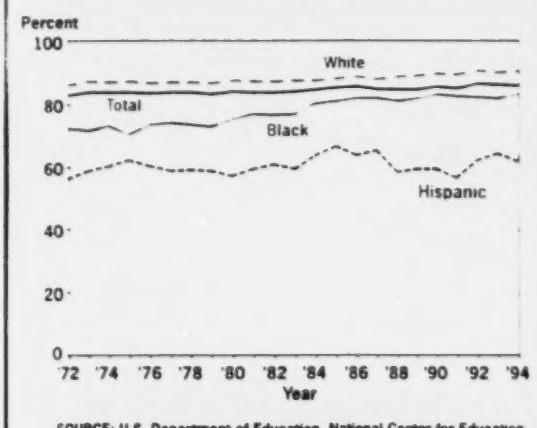
A recent study based on new company-level data also suggests that education has a significant impact on worker productivity. The National Center on the Educational Quality of the Workforce (EQW) recently conducted a survey of 3,000 establishments employing 20 workers or more. An EQW study of these data shows that a 10 percent increase in schooling is associated with an 8.6 percent increase in output. This estimated effect is large, and it is used to highlight the importance of education as a determinant of productivity. In fact, the EQW study argues that the effect of education on productivity is greater than the effect of a comparable percent increase in capital stock—a 10 percent increase in capital stock is associated with an increase in output of about 3.4 percent. This finding does not, however, demonstrate that increased education is necessarily a superior investment to increased capital because the EQW study makes no reference to the costs of a 10 percent increase in education compared with a 10 percent increase in capital. To identify the superior investment, one should determine whether a dollar spent on increased education generates a higher return than a dollar spent on increased capital.

INDICATOR 5

The Supply of Youth with High School and College Educations

The positive economic outcomes that ensue from additional years of schooling raise the issue of the extent to which youth who will enter the labor force have pursued additional years of education. The high school completion rate for young adults between the ages of 18 and 24 increased from 83 percent in 1972 to 86 percent in 1994 (figure 3.6). This slow increase, however, masks larger increases for particular racial–ethnic subgroups. The completion rate for white 18- to 24-year-olds is only two to three percentage points higher than it was 20 years ago. In contrast, the completion rate for black 18- to 24-year-olds has climbed substantially over the past 20 years (83.3 percent in 1994 compared with 72.1 percent in 1972). The completion rate for black 18- to 24-year-olds, however, still lags behind the completion rate for white 18- to 24-year-olds. The completion rate for Hispanic 18- to 24-year-olds is even lower than for blacks. Although the rate for Hispanics has fluctuated from year to year, it did not change significantly from 1972 through 1994.

Figure 3.6
High school completion rates for 18- to 24-year-olds not enrolled in high school, by race–ethnicity: 1972–94



SOURCE: U.S. Department of Education, National Center for Education Statistics, *Dropout Rates in the United States: 1994*; U.S. Department of Commerce, Bureau of the Census, October Current Population Surveys.

The percentage of the adult population that completes high school is noticeably higher for older adults than for younger adults. For example, 86 percent of 25- to 34-year-olds in 1991 had completed high school, compared with 81 percent of 19- to 20-year-olds. The higher proportion in the older age groups reflects the completion of high school by older students and the tendency for many who drop out of high school to eventually finish high school or acquire a General Education Development (GED) equivalency degree. The issue of whether equivalency degrees have value equal to a high school diploma in the workplace has been extensively debated. One recent study has shown that once the number of years of schooling completed is taken into account, individuals with equivalency degrees do not enjoy the same earnings or outcomes in the workplace as individuals with

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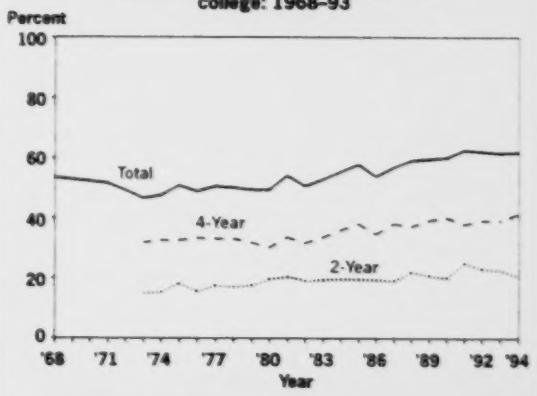
a high school diploma (Cameron and Heckman 1993). However, there can be a payoff in terms of earnings if people with equivalency degrees complete school before the age of 20 or if they use the degree as a means to access additional education and training.

Figure 3.7
Percentage of high school graduates enrolled in college in October following graduation, by type of college: 1968–93

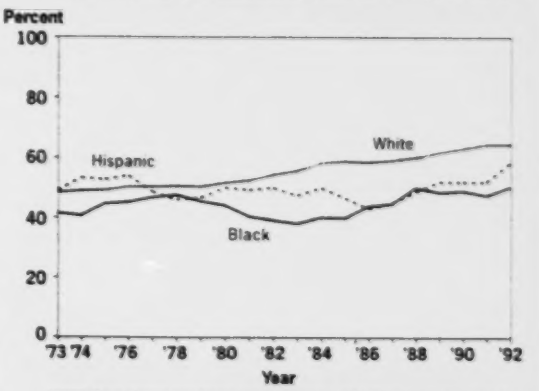


SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1996* and *The Condition of Education, 1991*; U.S. Department of Commerce, Bureau of the Census, October Current Population Surveys.

In summary, the rate of high school completion in the United States has increased slightly over the past 20 years. In light of the bleak economic prospects that confront those who do not complete high school, one might have expected a greater increase in high school completion. Some researchers have observed, however, that youth may not fully perceive the benefits of completing high school until several years later when differences in earnings and job stability become apparent.

In the postsecondary arena, a trend to pursue additional education exists. Young people leaving high school have increasingly gone on to two-year or four-year colleges (figure 3.7). More than three-fifths of high school graduates enrolled in college shortly after graduating, compared with about one-half who did so 20 years ago. The increase is fairly similar for high school graduates who go to two-year and four-year colleges. However, the differential participation of subgroups within the college-going population is much more uneven. White students have demonstrated a consistent pattern of growth in college enrollment, whereas the rate of enrollment for black high school graduates increased in the 1970s, decreased in the early 1980s, and climbed back to the higher level in the late 1980s and early 1990s (figure 3.8). Patterns for Hispanic students have been similarly inconsistent over the past 20 years. Part of the volatility in the college enrollment rates for black and

Figure 3.8
Percentage of high school graduates enrolled in college in October following graduation, by race–ethnicity: 1973–92



NOTE: Data shown are three-year averages. The three-year average for 1992 is the average percentage of graduates enrolled in college in 1991, 1992, and 1993.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*; U.S. Department of Commerce, Bureau of the Census, October Current Population Surveys.

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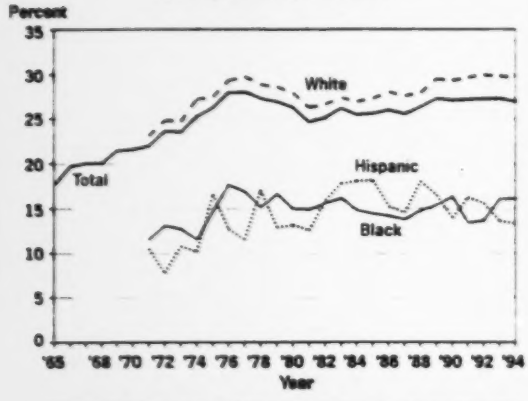
Hispanic students that is reflected in figure 3.8 is due to the relatively small samples used to calculate these rates.

Figure 3.9
Percentage of high school graduates ages 25–29 years who have completed four years or more of college, by race–ethnicity: 1965–94



SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995: The Condition of Education, 1995*; U.S. Department of Commerce, Bureau of the Census, March Current Population Surveys.

Although approximately 40 percent of high school graduates immediately enroll in a four-year college, considerably fewer earn a diploma. In 1994, approximately one-quarter of high school graduates ages 25–29 years had completed four or more years of college (figure 3.9). Black and Hispanic adults of this age were less likely to have completed this level of education (16 and 13 percent, respectively, in 1994) than white adults (30 percent).

The rate of college completion has not changed much over the past 20 years. The completion rate of 27 percent in 1994 was only slightly higher than the rate from 20 years before. This slight increase, which might seem puzzling given the increased economic advantages associated with more years of education, can be explained by several factors. First, the increase in the returns to education occurred largely in the 1980s. The youngest high school graduate represented in figure 3.9 would have entered college in the mid-1980s, before much of the increase in the returns to education was widely recognized. Second, the increase in financial and other costs associated with investing in education over this period may have reduced the number of students who chose to pursue a college degree (U.S. Department of Education 1995). Finally, changes in the composition of the population of youth and young adults may also have affected college completion rates. Throughout most of the period represented in figure 3.9, the college completion rate for the overall population of high school graduates closely tracked the completion rate for whites because whites dominated the population of high school graduates. But in recent years, the completion rate for the population has gradually begun to diverge from the completion rate for whites as blacks and Hispanics become a larger proportion of the population. This trend will have a negative impact on the total college completion rate because the latter two groups, which have relatively low completion rates, will be weighted more heavily in the total population.

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DISCUSSION: USING EDUCATION TO INCREASE EARNINGS AT THE NATIONAL LEVEL

The strong link between education and earnings at the individual level implies that the education of the work force as a whole also plays a role in determining the productive capacity of the work force and the average earnings among all workers. As individuals increase their earnings by acquiring additional education, they also expand the productive capacity of the economy as a whole. This description of the link between education and productivity is consistent with the findings from the growth-accounting studies discussed in chapter 2, which estimated the statistical link between increases in education of the work force and increases in labor productivity. Productivity growth, therefore, can be supported by encouraging students to pursue additional schooling. For example, policies such as the provision of loans and educational grants that increase access to college can have a positive impact on productivity and on average earnings.

The ability to increase the earnings of the work force in general through increased education is limited however, both because of market responses and because individuals vary in their capabilities. We cannot, for example, ensure that everyone will have a salary equal to the average salary for attorneys simply by putting everyone through college and law school. First, not all people are prepared to be attorneys, regardless of the training received, and most of the new entrants would probably be less capable than the average student who becomes an attorney on his or her own. In addition, flooding the market with attorneys would inevitably decrease the salaries for all attorneys (and the price of legal services) due to excess supply. Hence, average pay in general and the earnings differentials between occupations and educational levels are sensitive to a dynamic labor market.

The link between education and earnings of the work force is also somewhat tenuous because many other factors affect the productivity of workers and their earnings. For example, as discussed in chapter 2, the availability of capital is an important determinant of labor productivity. Labor productivity is also affected by changes in production technology and the ways in which work is organized.

Some researchers have questioned the degree to which estimates of the impact of education on individual earnings levels are useful for evaluating the social benefit of increases in education. Levin and Kelley (1994), for example, argue that the estimated returns to education overstate the actual social benefits of education, claiming that changes in aggregate educational attainment do not bring about the increases in earnings that estimates of individual returns to education imply. As evidence, Levin and Kelley point out that the increases in education from 1968

through 1987 were accompanied by a decline in median earnings rather than an increase as implied by positive returns to education. But estimates of the returns to education are based on the assumption that other factors remain constant, and, as pointed out above, this is not the case in a dynamic market. The drop in earnings from 1968 through 1987 was not caused by the increase in education over the same period. Rather, it is likely to have been caused by factors beyond the changes in education, such as increased competition from foreign producers or decreased power of labor unions. The increase in education may have kept median earnings from dropping even lower than it did.

CONCLUSIONS

- ***The transition from high school directly into the labor market can be difficult, and unemployment rates are high for recent high school dropouts and graduates not enrolled in college. These rates have increased over the past 30 years. They are higher among dropouts than among graduates, and higher among black graduates than among white graduates.***

- ***The differences in earnings between college graduates, high school graduates, and high school dropouts have increased over time, suggesting that the economic returns to education have also increased. Recent estimates confirm this trend—economic returns to a college education have increased dramatically, while the economic returns to a high school education have increased modestly. These changes have occurred as the average real wages of college graduates have increased and the real wages of high school graduates and dropouts have declined.***

- ***The returns to education have increased over time, partly in response to the use of new production technologies, which increase the demand for highly educated workers and decrease the demand for production workers. Supply factors also play a role, as the proportion of labor force entrants with college degrees stopped growing in the 1980s, following rapid increases in the 1970s. Meanwhile, competition from immigrants and imports increased the effective supply of less-educated workers.***

- ***It is not likely that increases in the returns to postsecondary education result primarily from alleged declines in the quality of high school and primary education in the United States. The real wage decreases experienced by high school graduates occurred among older workers as well as young workers, and the older workers attended school before the alleged decline in the quality of education.***

■ *The factors that caused the returns to education to increase also contributed to greater income inequality in the economy overall. Researchers have argued that growing income inequality may constrain productivity growth, and this argument has recently received some empirical support.*

■ *The ability of increases in education to increase aggregate earnings is somewhat limited. First, large changes in education will generate market responses that will limit the earnings impact. Second, many other factors affect earnings, limiting the degree to which education alone can dictate earnings levels.*

■ *Over the past 20 years, high school and college completion rates in the United States have risen slightly while college enrollment rates have increased substantially. More than three-fifths of high school graduates enroll in college shortly after graduating, compared with about half who did so 20 years ago. The expansion in college enrollment reflects positive enrollment trends at both two-year and four-year colleges.*

CHAPTER 4

Economic Consequences of Educational Achievement

Students who complete higher levels of schooling realize greater economic returns, as measured by employment status and wage rates. But attainment is only one way to measure the educational experience and the degree to which education prepares students for work. Students within broad attainment categories may vary significantly in the extent and content of their knowledge and in their ability to think, learn, and communicate. This knowledge and these skills are likely to affect a student's ability to eventually succeed in the labor market, even after controlling for attainment. The ability of students to succeed is determined not only by the degrees they earn and the number of years that they attend school, but also by what they learn. Presumably, achievement in an academic environment is a reflection of skills and knowledge, and test scores act as indicators of academic achievement.

In this chapter, we investigate the economic consequences of educational achievement as measured by test scores. We begin by exploring the degree to which labor market outcomes (employment status and wage rates) of labor force participants are related to measures of individual educational achievement. Our indicators are derived from longitudinal data on a sample of young workers from the National Longitudinal Study of Youth (NLSY). We then consider trends in achievement of U.S. students over the past 25 years, as reflected in performance trends on the National Assessment of Educational Progress.

INDICATOR 6

Achievement Test Scores and Employment Status

One approach to assessing the importance of academic skills in the labor market is to examine the link between achievement test scores and labor market outcomes. Although test scores may not fully measure all facets of academic achievement, they form a quantitative basis from which to begin investigating the economic payoffs to achievement. The first set of indicators, which address the unemployment experiences of workers according to their performance on achievement tests, are based on data from the NLSY. Part of this database was constructed from responses of NLSY sample members to the Armed Services Vocational Aptitude Battery (ASVAB).[30] The ASVAB consists of tests to measure knowledge in 10 areas.[31] Using the longitudinal data from the NLSY from 1979 through 1993, we examine economic outcomes for sample members ages 19–31 years according to the scores in three of these areas: mathematics knowledge, general science, and paragraph comprehension.[32]

Workers who have higher academic skills are better able than workers with lower academic skills to avoid unemployment. Figure 4.1 shows that workers in the NLSY with lower ASVAB test scores in mathematics, science, and paragraph comprehension have a higher probability of being unemployed than workers with higher scores.[33] For example, among 28-year-olds, 2.9 percent of workers in the top quartile of the mathematics test are unemployed, compared with 7.3 percent of workers in the other three quartiles combined. The patterns are similar for the unemployment rates for workers by science and paragraph comprehension scores. In all subjects, workers ages 19–22 years in the bottom two quartiles have higher unemployment rates than those in the top two quartiles. For example, workers ages 19–22 years with mathematics scores in the third quartile have unemployment rates between 14 and 21 percent, and those in the bottom quartile have unemployment

[30]The administration of the ASVAB to the NLSY sample members is referred to as the Profile of American Youth (U.S. Department of Defense 1982).

[31]These 10 areas include general science, arithmetic reasoning, word knowledge, paragraph comprehension, numerical operations, coding speed, auto and shop information, mathematics knowledge, mechanical comprehension, and electronics information.

[32]Because all sample members completed the ASVAB in the summer of 1980, the age of respondents at the time of testing ranged from 16 through 23 years. To control for differences in age at testing, we assigned individuals to age-specific performance quartiles for each subject area based on their age at testing.

[33]We also examined the results for arithmetic and vocabulary scores, but the findings are similar to those for mathematics and paragraph comprehension, respectively. We therefore excluded the arithmetic and vocabulary results from our presentation.

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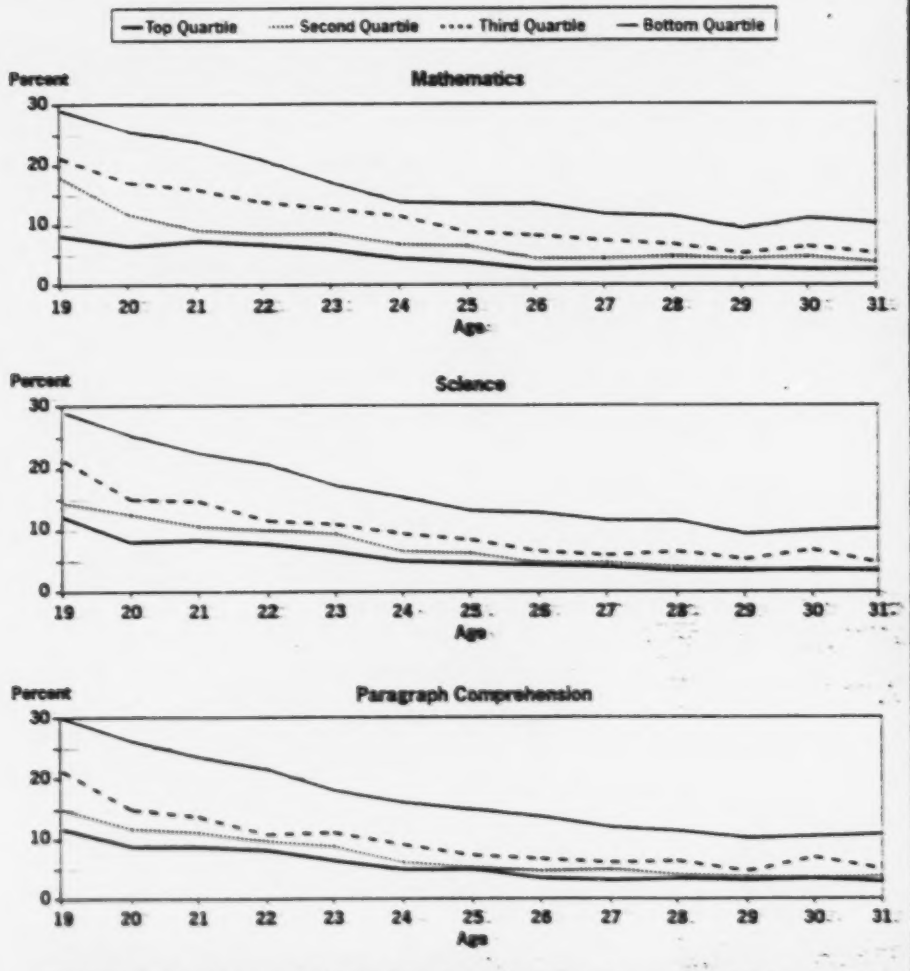
Figure 4.1
Unemployment rate of civilian workers ages 19–31 years, by age-adjusted ASVAB score quartile



NOTE: ASVAB is the Armed Services Vocational Aptitude Battery. To control for differences in age at testing, individuals were assigned to age-specific performance quartiles for each subject area based on their age at testing. Respondents who were out of the labor force at any age were excluded from the sample for that age.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Longitudinal Survey of Youth, 1979–83.

rates of 21 to 29 percent. Differences exist even for older workers. The 31-year-old workers in the bottom quartile of any test have an unemployment rate of about 10 percent, compared with 3 percent for workers in the top quartile.

Some differences in unemployment rates by test scores exist even after controlling for broad differences in educational attainment. Figure 4.2 shows that at least for workers ages 19–22 years who are high school graduates or have 1–3 years of college, unemployment rates tend to be lower for workers with scores in the top

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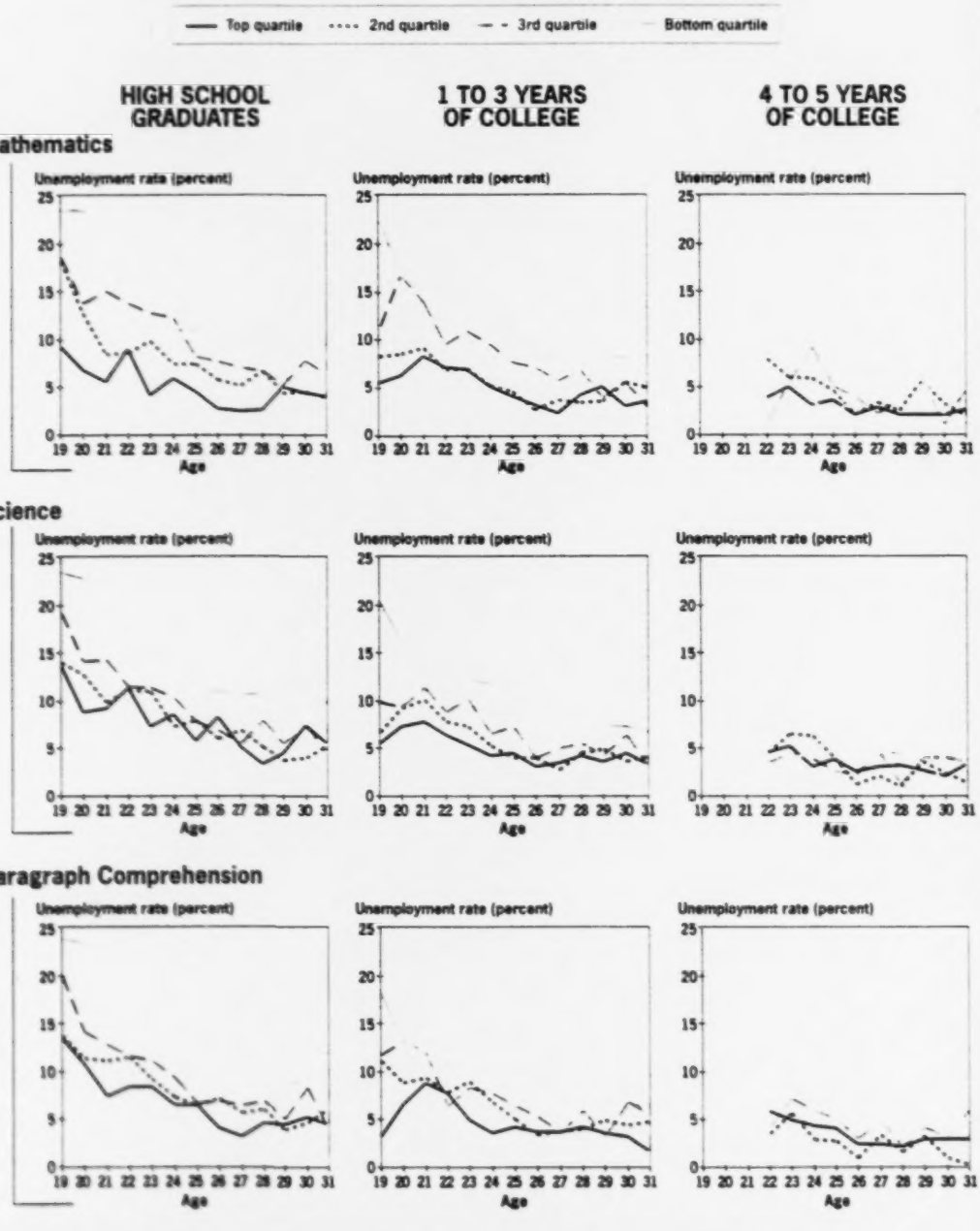
Figure 4.2
Unemployment rate of civilian workers ages 19–31 years, by educational attainment and age-adjusted ASVAB score quartile



NOTE: ASVAB is the Armed Services Vocational Aptitude Battery. To control for differences in age at testing, individuals were assigned to age-specific performance quartiles for each subject area based on their age at testing. Respondents who were out of the labor force at any age were excluded from the sample for that age. Data points based on fewer than 30 observations are excluded from the figure.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Longitudinal Survey of Youth, 1979–93.

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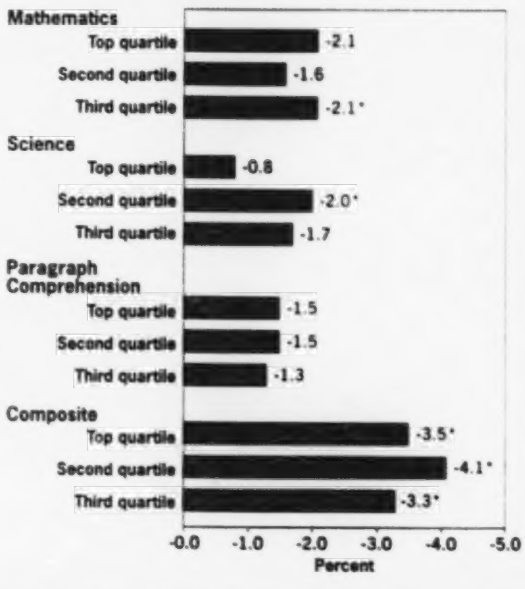
quartile than workers in the bottom quartile. For 20-year-old high school graduates, for example, the unemployment rate for workers with mathematics scores in the bottom quartile is 23 percent, compared with less than 10 percent for workers in the top quartile. In contrast, for workers with four to five years of college, there do not appear to be consistent substantial differences in unemployment rates by test scores (third column of graphs in figure 4.2).

Regression estimates also demonstrate that the probability of unemployment is negatively related to test scores. These estimates, which are based on the sample of 28-year-olds from the NLSY, largely support the findings shown in the preceding two figures.[34] A composite of the three test scores shows that 28-year-old workers in the top three quartiles of test scores have a roughly 3 to 4 percent lower probability of being unemployed than workers in the bottom quartile (figure 4.3). The differences in unemployment probability between the top three quartiles, however, are statistically insignificant.

Figure 4.3
Estimated relationship between test scores and unemployment probability (as compared to being in the bottom quartile), for 28-year-old workers



*Significantly less than zero at the 95 percent confidence level in a two-tailed test.

NOTE: The number shown is the percentage impact on the unemployment probability of being in the specified quartile compared to being in the bottom quartile.

SOURCE: Authors' calculations based on the National Longitudinal Survey of Youth, 1979-93 data.

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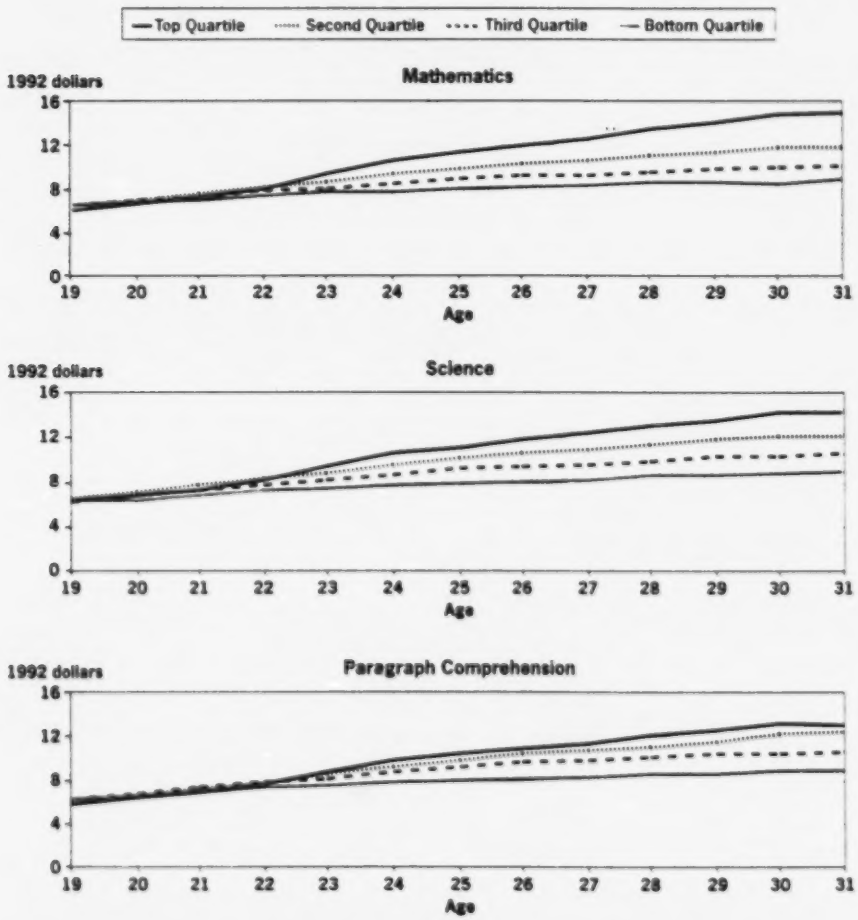
[34]The regression equations include as explanatory variables a set of quartile indicators for each ASVAB subject area in addition to sets of indicator variables to control for education, father's education, mother's education, local unemployment rates, gender, race-ethnicity, and year of interview. The regression was run on 28-year-olds in an effort to look at the latest age possible and still use most of the sample.

INDICATOR 7

Achievement Test Scores and Wage Rates

Workers with higher achievement test scores earn higher hourly wages than workers with low test scores. Figure 4.4 shows mean hourly wage rates for workers by score quartile for the mathematics, science, and paragraph comprehension tests. For workers 23 years and older, those with higher scores in each of the

Figure 4.4
Mean hourly rate of pay for civilian workers ages 19–31 years, by age-adjusted ASVAB score quartile



NOTE: ASVAB is the Armed Services Vocational Aptitude Battery. Respondents reporting hourly pay of less than $1.00 or greater than $100.00 (1992 dollars) at any given age were excluded from the sample for that age. To control for differences in age at testing, individuals were assigned to age-specific performance quartiles for each subject based on their age at testing.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Longitudinal Survey of Youth, 1979–93.

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three subjects earn higher hourly wages than workers with lower scores. For example, 28-year-old workers with mathematics scores in the top quartile earn a mean hourly wage of $13.50 (in 1992 dollars) compared with a mean hourly wage of $9.84 earned by workers in the other three quartiles combined—a difference of 37 percent.

Wage differences by test scores may grow larger as workers get older. Murnane, Willett, and Levy (1995) showed that test scores are a much stronger predictor of wages six years after high school graduation than two years after graduation.[35] Bishop (1991) suggests two reasons for this age effect. First, academic achievement may improve access to jobs that offer more training opportunities, therefore creating a greater potential for wage growth. Second, employers may be unable to evaluate the skills of new hires, because they learn about a particular worker's productivity only over time. In this case, workers with higher academic skills are rewarded with higher pay only after the delayed realization of their greater productivity.

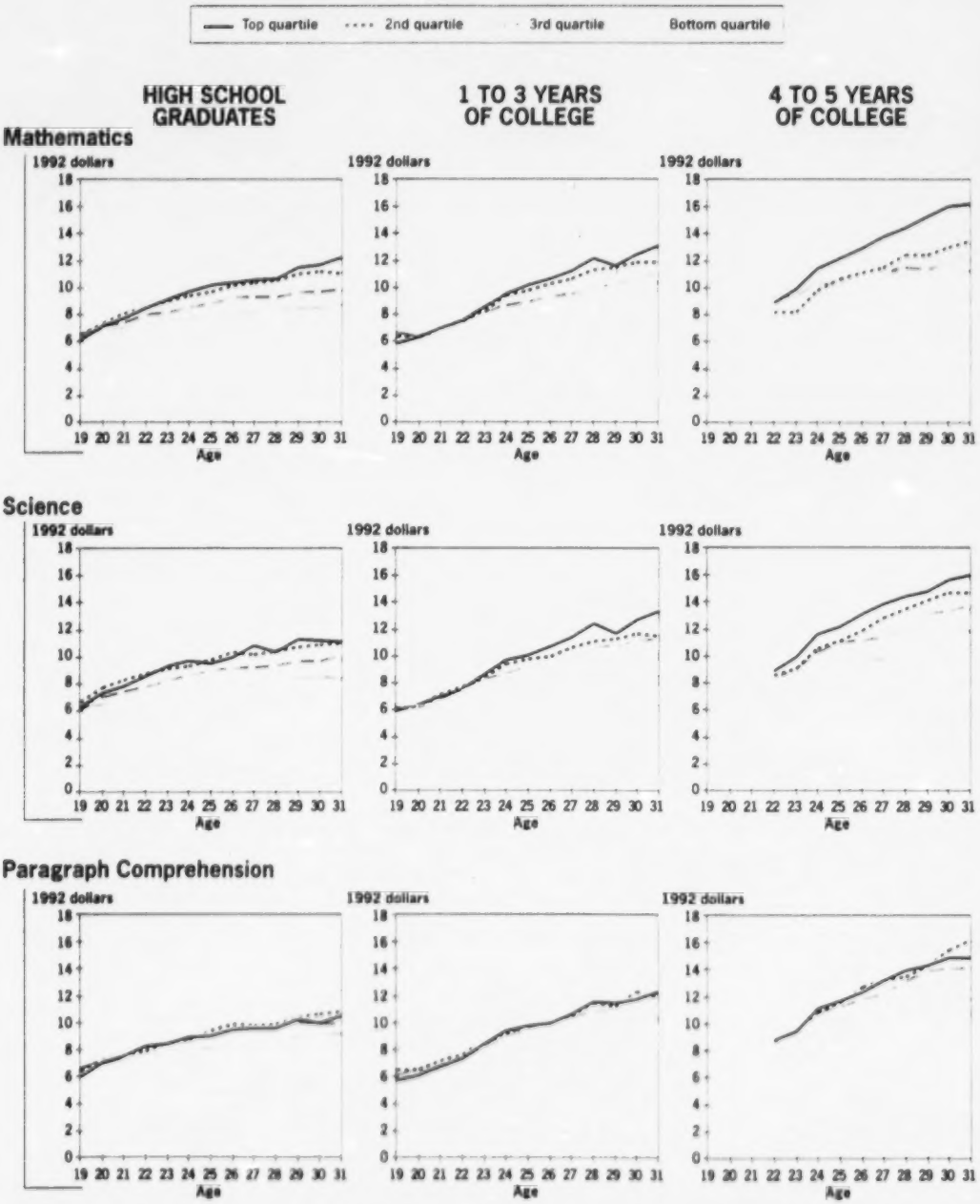
The effect of test scores on wages also appears to have expanded in recent years. Murnane, Willett, and Levy (1995) find that the relationship between scores on basic skills tests conducted in grade 12 and subsequent wages of young workers was stronger in the mid-1980s than in the late 1970s. They conclude that a high school senior's mastery of basic skills is an increasingly important determinant of subsequent wages.

The wage differences by test scores shown in figure 4.4 are not simply attributable to differences in educational attainment. Some differences still exist even after controlling for broad measures of attainment. For example, workers in the categories of attainment shown in figure 4.5 who scored in the top two quartiles of mathematics and science generally earn more at ages 28–31 years than those who scored in the bottom two quartiles.

Regression estimates based on these data also demonstrate that workers with higher test scores earn higher wages, even after controlling for other factors. These findings, which are presented in figure 4.6, show that overall performance on the achievement tests is strongly and positively correlated with wages for 28-year-olds. Workers with composite test scores in the top two quartiles earn about 20 percent more than workers in the bottom quartile and about 10 percent more than workers in the third quartile (figure 4.6).

[35]Murnane, Willett, and Levy (1995) base their findings on data from the National Longitudinal Study of the High School Class of 1972 and the High School and Beyond Survey, both of which contain data on academic test scores.

Figure 4.5
Mean hourly rate of pay for civilian workers ages 19–31 years, by educational attainment and age-adjusted ASVAB score quartile



NOTE: ASVAB is the Armed Services Vocational Aptitude Battery. Respondents reporting hourly pay of less than $1.00 or greater than $100.00 (1992 dollars) at any given age were excluded from the sample for that age. Data points based on fewer than 30 observations are excluded from the figure.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Longitudinal Survey of Youth, 1979–93.

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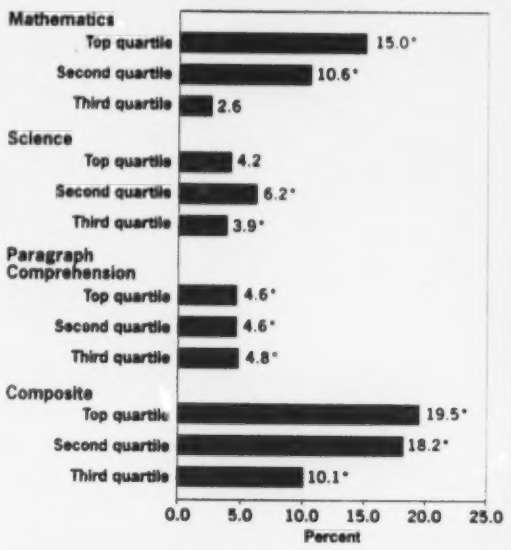
On the surface, these findings appear to contradict the findings of Bishop (1991; 1992), which suggest that achievement test scores are not strong predictors of employment and earnings outcomes for the NLSY sample respondents. But the differences between Bishop's findings and our findings may be due to the use of later data in this report. At the time of Bishop's studies, longitudinal data on employment and wages were available only for a relatively young sample of workers.[36] This study reflects the addition of seven years of longitudinal data to the time frame used by Bishop, so it is based on substantial samples of workers up to about 31 years old. The additional data allow for the examination of wage differences among samples of relatively older workers, which, as was discussed earlier, tend to be larger than the wage differences among younger workers.

Figure 4.6
Estimated relationship between test scores and hourly wage rates (as compared to being in the bottom quartile), for 28-year-old workers



*Significantly greater than zero at the 95 percent confidence level in a two-tailed test.

NOTE: The number shown is the percentage impact on the hourly wage of being in the specified quartile compared to being in the bottom quartile.

SOURCE: Authors' calculations based on the National Longitudinal Survey of Youth, 1979–93 data.

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[36]Bishop (1991; 1992) used data through 1986.

INDICATOR 8

Trends in Student Achievement Test Scores

Trends in student achievement have recently received a great deal of attention. This interest has been fueled, in part, by the growing availability of published aggregate achievement test scores that have been collected to monitor student academic progress over time. Drawing upon data from numerous different achievement tests, the Congressional Budget Office (1986) found that most indicators of student achievement show a constant or an upward trend in the aggregate scores, which was interrupted by a period of decline beginning in the mid-1960s and ending in the mid- to late 1970s. Table 4.1 shows the years marking the decline by different sources of achievement test data. Since the end of this decline, test scores have generally increased over time and, according to several measures of academic achievement, most have reached the levels of average scores that existed before the period of decline.

Table 4.1
Onset and end of the achievement decline as indicated by selected tests

Test	Decline onset	Decline end
SAT	1963	1979
ACT composite	1966	1975
ITBS, grade 5	1966	1974
ITBS, grade 8	1966	1976
ITED, grade 12	1968	1979

SAT = Scholastic Assessment Test
ACT = American College Testing
ITBS = Iowa Test of Basic Skills
ITED = Iowa Test of Educational Development

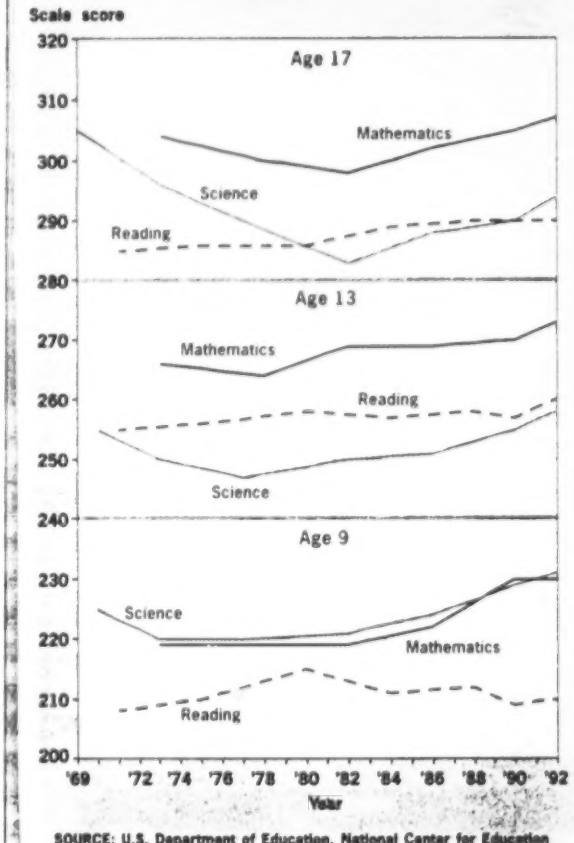
SOURCE: Congressional Budget Office, *Trends in Educational Achievement*, 1986.

One way to study trends in student achievement is to draw upon cross-sectional data to consider changes in the level of academic performance of typical students over time. The most widely referenced source of cross-sectional achievement data is the National Assessment of Educational Progress (NAEP), which has provided mathematics, science, and reading achievement test scores for representative samples of the nation's 9-, 13-, and 17-year-olds periodically over

the past 20–25 years.[37] The NAEP data show that while reading test scores have slowly increased for 13- and 17-year-olds during the past two decades, science achievement test scores declined for 13- and 17-year-olds through the 1970s and early 1980s, and mathematics test scores declined for 17-year-olds (see figure 4.7). On average, achievement test scores of 17-year-olds fell by 6 points in mathematics and 13 points in science from 1973 through 1982.

This declining trend in mathematics and science achievement for 17-year-olds reversed in the early 1980s. Figure 4.7 shows that achievement in mathematics and science increased throughout the 1980s and into the 1990s for all ages. For all ages, it is generally the case that the 1992 NAEP achievement test scores are at least as high as those from the late 1960s/early 1970s. The only exception is 17-year-olds in science. The mean science test score of these students in 1992 was lower than their achievement status in 1969.

Figure 4.7
Trends in average U.S. achievement in science, mathematics, and reading: 1969–92



SOURCE: U.S. Department of Education, National Center for Education Statistics, *The National Assessment of Educational Progress: 1992 Trends in Academic Progress, 1994.*

There are at least two possible explanations for the apparent reversal in the trend for achievement in mathematics and science. First, the negative public attention to the decline in test scores in the late 1970s and early 1980s could have stimulated a more aggressive and ultimately successful effort to generate higher achievement. Much of the concern over student performance was reflected in *A Nation at Risk* (U.S. Department of Education 1983). This document denounced the falling achievement levels of American youth and encouraged a more rigorous mathematics and science education program for all students. Subsequent reform efforts may have contributed to the observed improvement in achievement test scores from 1982 through 1992.

[37] In addition, NAEP writing test scores have been collected and reported for 4th, 8th, and 12th graders periodically since 1984.

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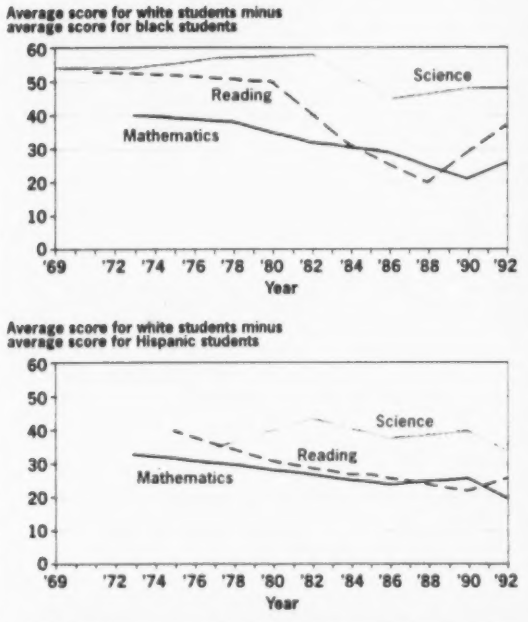
Second, it could be that as the use and importance of standardized tests have grown over the past two decades, students' ability to succeed at these tests has concomitantly increased, regardless of true gains in achievement. There are several possible sources of test score corruption. The growing reliance on standardized tests as a tool for making schools and teachers accountable is likely to have inadvertently encouraged coaching or inappropriate teaching to the tests (Koretz 1994). Some practitioners contend that it is easier to teach to the test in mathematics and science than in reading. This view is consistent with the pattern of improvement in NAEP scores. In addition, it could be that students have simply benefited from additional experience with this type of test. Their familiarity with standardized tests could account for a large portion of the observed improvement in scores over the past decade.

Figure 4.8
Difference in average NAEP proficiency scores for whites and blacks and whites and Hispanics age 17 years, by subject: 1969–92



SOURCE: U.S. Department of Education, National Center for Education Statistics, *The National Assessment of Educational Progress: 1992 Trends in Academic Progress*, 1994.

Trends in achievement by race-ethnicity are an indication of how the educational enterprise has performed in terms of equity. Much attention has focused on equalizing educational resources among racial-ethnic groups over the past two decades, and a trail of litigation—ranging from *Brown v. Board of Education* in 1957 to cases in over half the states in the early 1990s—documents this movement. Trends in achievement by race-ethnicity are especially salient given the relationship between performance in school and economic outcomes as measured by employment and earnings.

The NAEP data show that over the past 20 years, the average achievement of black and Hispanic 17-year-olds has generally improved more over time than that of white 17-year-olds. Figure 4.8 shows that while gaps have consistently separated the average scores of white and minority students, the magnitude of these gaps generally has declined over time in mathematics and reading. The achievement gap between white and black students decreased by 35 percent in mathematics from 1973 through 1992, and by 30 percent in reading from 1971 through 1992. This narrowing of the mathematics and reading achievement gaps occurred during the 1970s and 1980s; since then, the gap has increased in reading and has remained steady in mathematics.

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Similarly, the achievement gap between white and Hispanic students closed by 39 percent in mathematics between 1973 and 1992, and by 35 percent in reading between 1975 and 1992. Less progress has occurred in the area of science—the apparent convergence of white and minority test scores for 17-year-olds is not significant. Furthermore, despite the progress realized in narrowing the achievement gaps, noteworthy differences in test scores between white and minority students still remain.

The NAEP achievement scores have also been reported in terms of proficiency levels.[38] When the scores are considered in terms of proficiency levels, there is some indication that among 17-year-olds, improvements have been realized in the middle levels of proficiency, while little progress has been made at the top level. Student proficiency in the lower levels of mathematics and science has remained relatively constant over time. Figure 4.9 shows that in mathematics, some progress was made among 17-year-olds in beginning problem solving (level two) and reasoning (level three) from 1978 through 1992, but the proportion of 17-year-olds that have mastered multi-step problem solving and algebra (level four) did not change over the same period. In science, the percentage of 17-year-old students able to analyze scientific procedures and data (level three) increased by 10 points from 1982 through 1992, but by only five percentage points from 1977 through 1992. Furthermore, no increase is apparent in the percentage of students able to integrate specialized scientific information (level four). There is still work to be done in linking these proficiency levels with educational productivity in terms of economic returns. It may be that different levels of proficiency are more relevant to different types of jobs. Nonetheless, limited progress at the upper proficiency levels in mathematics and science may be a source of concern.

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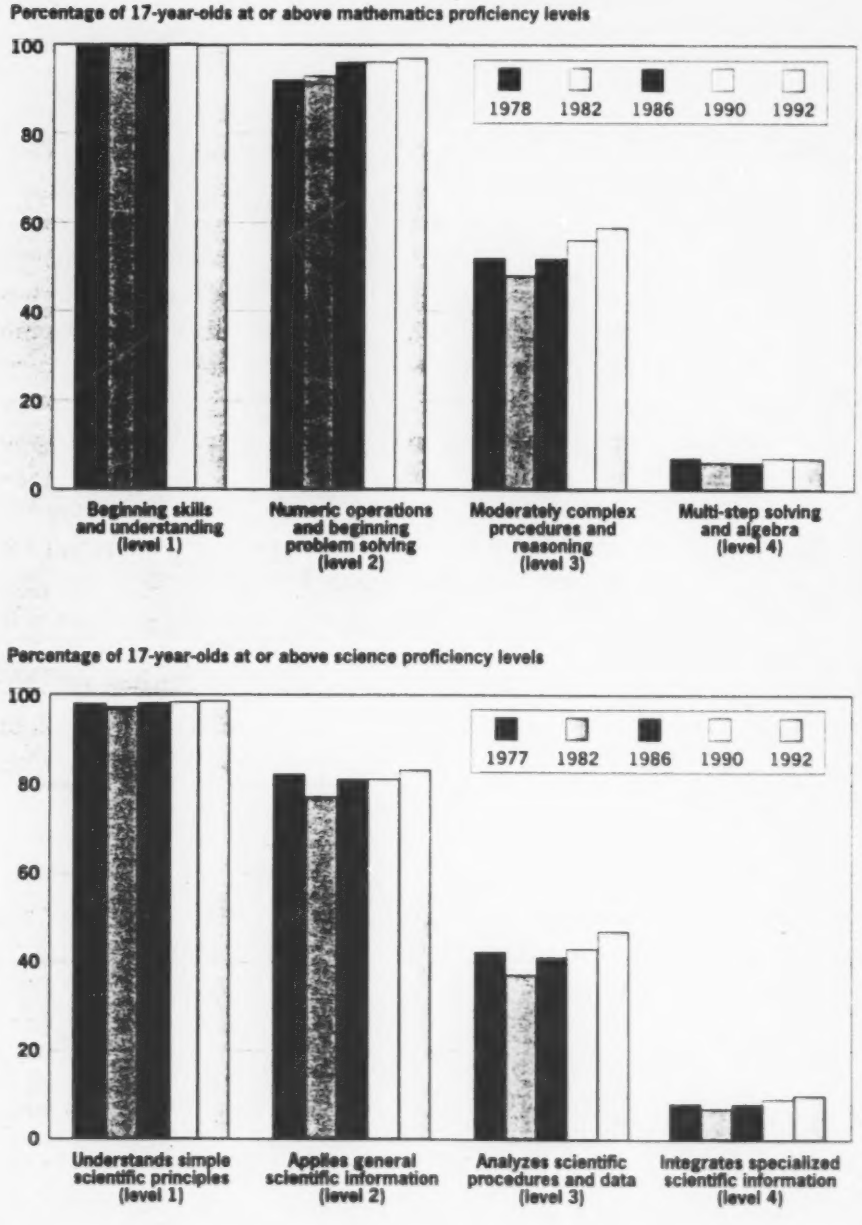
[38]For each subject area in the NAEP, experts anchored five levels of proficiency at 50-point intervals on the subject-specific trend scale and identified the types of knowledge and skills associated with each level (see U.S. Department of Education 1994c for a more thorough description of the various proficiency levels). In this study, we present results for 17-year-old students and include information only on the top four levels of mathematics and science proficiency (scores of 200, 250, 300, and 350), since 100 percent of 17-year-olds consistently reach at least the lowest proficiency level (a score of 100) in these subjects.

Figure 4.9
Trends in percent of students at or above four mathematics and four science proficiency levels: 1977–92



SOURCE: U.S. Department of Education, National Center for Education Statistics, *The National Assessment of Educational Progress: 1992 Trends in Academic Progress*, 1994.

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CONCLUSIONS

■ *Workers with high academic achievement, as measured by achievement test scores, earn more and are unemployed less than workers with lower scores. Some differences in wages and unemployment tend to exist even within broad categories of educational attainment. For high school graduates with higher test scores, there is generally both a wage payoff for older workers and lower unemployment for younger workers. For workers with four to five years of college, there is no clear unemployment payoff, but there is a wage payoff associated with mathematics and science scores. Regression estimates further support the positive link between test scores and labor market outcomes.*

■ *Numerous achievement tests show constant or upward trends in the aggregate scores of students, interrupted by a period of decline beginning in the mid-1960s and ending in the mid- to late 1970s. According to NAEP scores, there generally has been no overall decline in math, science, or reading achievement over the past 20 years. In general, scores have increased through the 1980s and early 1990s, offsetting some prior declines in achievement in the 1970s. However, little progress has been realized in the number of students mastering the top levels of proficiency in mathematics and science.*

■ *The achievement gap that has historically separated white and minority students has decreased over the past 20 years in math and reading, although large gaps still remain. The convergence of scores between the races is due to increases in the scores of minority students coupled with stability or smaller increases in scores of white students. This suggests that the largest racial group (white students) has made less progress, on average.*

CHAPTER 5

Economic Consequences of Adult Literacy

The previous chapter linked academic achievement of individuals as students to their eventual performance in the labor market. Alternative measures based on adult literacy can be used to evaluate adults once they are in the labor market. The term *literacy* in this context refers to the skills individuals need to use printed and written information, including quantitative information, to function successfully in their work and personal lives. Some observers are concerned that there is a mismatch between the supply of and the demand for literacy skills in the labor force in the United States. Although not all skills required in the workplace can be characterized as literacy skills, they are likely to play an important role in the workplace. They may even be more important than academic achievement for the population at large because they are likely to be important in all types of tasks and settings.

Information about adult literacy was provided recently by the 1992 National Adult Literacy Survey (NALS) sponsored by the National Center for Education Statistics. The survey was initiated to fill the need for accurate and detailed information on the English literacy skills of America's adults. For the purpose of the survey, a national panel of experts defined literacy as "using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential" (U.S. Department of Education 1993a). To investigate and measure literacy, the survey contained a series of exercises that required respondents to read and interpret written material, compare and contrast findings, complete various forms, make arithmetic calculations, and write short letters. Respondents' proficiencies were measured on prose, document, and quantitative scales, ranging from 0 to 500. To capture the progression of information-processing skills, each scale was divided into five levels: level one (0 to 225), level two (226 to 275), level three (276 to 325), level four (326 to 375), and level five (376 to 500). A low score (level one) indicates that an individual has very limited skills in processing information from tables, charts, graphs, and maps, even those that are brief and uncomplicated. On the other hand, a high score (level five) indicates advanced skills in performing a variety of tasks that involve the use of complex documents.[39]

In this chapter, we examine the relationship between literacy scores and labor market outcomes to identify the literacy skills that pay off in the labor market. The data necessary to examine the impact of literacy on worker productivity is unavailable. Therefore, in examining the link between literacy and productivity, unemployment and earnings are used as indicators of productivity.

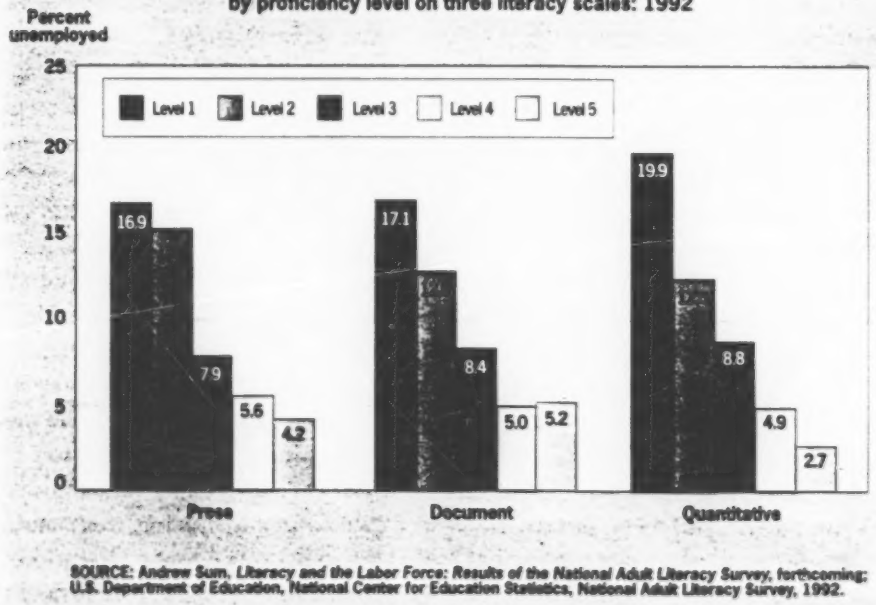
[39] A detailed description of the prose, document, and quantitative literacy levels is contained in U.S. Department of Education (1993a).

INDICATOR 9

Literacy and Unemployment

Unemployment tends to be correlated with low literacy. Figure 5.1 shows that the unemployment rate is generally higher for individuals with lower literacy levels on all three of the scales used in the NALS. Unemployment rates are especially high for workers in the two lowest literacy levels on each scale (levels one and two). For instance, the unemployment rate for these workers ranges from 12 percent for those with level two quantitative skills up to 20 percent for those with level one quantitative skills. The unemployment rate for workers in the top three literacy levels in each scale (levels three through five) is 9 percent or less.

Figure 5.1
Unemployment of adult labor force participants, by proficiency level on three literacy scales: 1992



SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

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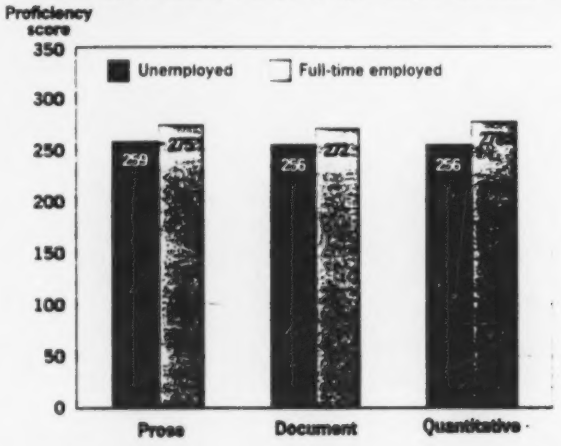
Literacy affects unemployment even beyond the degree to which it is correlated with educational attainment. Within most categories of attainment, such as high school diploma only (figure 5.2), the average proficiency of the unemployed is less than that of the employed. Even after controlling for levels of educational attainment, workers with higher literacy levels are still less likely to be unemployed. This finding is supported by regression analysis of these literacy data in Sum (forthcoming), which shows that a 60-point increase in prose, document, or quantitative literacy reduces the probability of unemployment by about 2 percentage points.

Figure 5.2
Average proficiencies of the unemployed and full-time employed with high school diplomas only, by literacy scale: 1992



SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

The connection between literacy and unemployment may exist for many reasons. First, if individuals with low literacy levels are less productive, they may be at greater risk of being laid off than workers with higher levels of literacy. This would translate into greater layoff frequency and more unemployment. Once unemployed, low-literacy workers may also have more trouble finding a new job than workers with higher literacy. Low-literacy workers who lose their jobs would therefore probably face longer unemployment spells than high-literacy workers who lose their jobs. This could happen either because low literacy tends to make workers less attractive to employers or because they cannot search for work as effectively as other job seekers. Finally, those with low literacy levels may make unwise labor market decisions that negatively affect their job stability. For example, low-literacy workers may not be able to accurately evaluate alternative job prospects; therefore, they quit jobs on the basis of flawed evaluations of their prospects.

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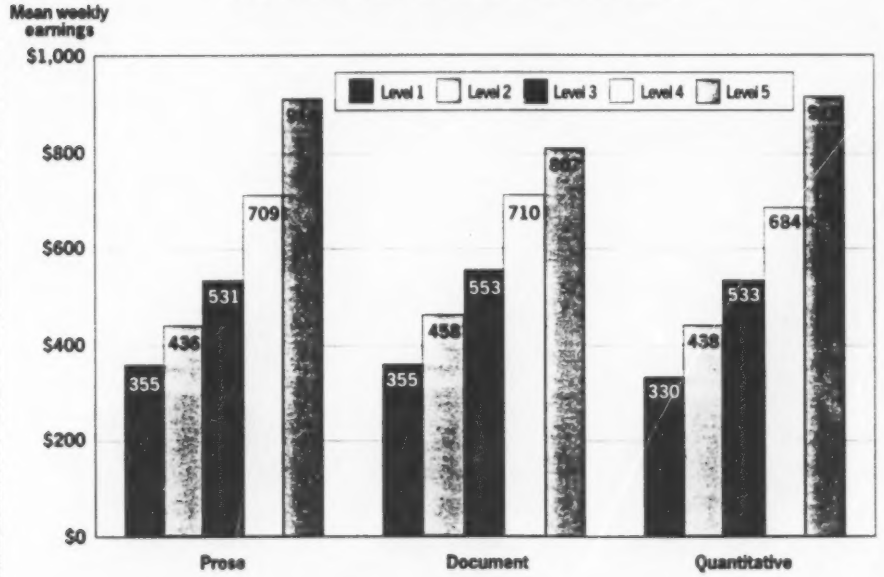
INDICATOR 10

Literacy and Earnings

Overall, full-time workers with high literacy skills earn more, on average, than full-time workers with low literacy skills. The earnings advantage for high-literacy workers is evident for each of the three literacy scales. On the prose scale, for example, full-time workers at level three earn a mean weekly wage that is 50 percent higher than the wage for their counterparts at level one, and those at level five earn a weekly wage that is 71 percent higher than the average wage of those at level three (figure 5.3).

Figure 5.3
Mean weekly earnings of full-time workers, by proficiency level on three literacy scales: 1992



SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

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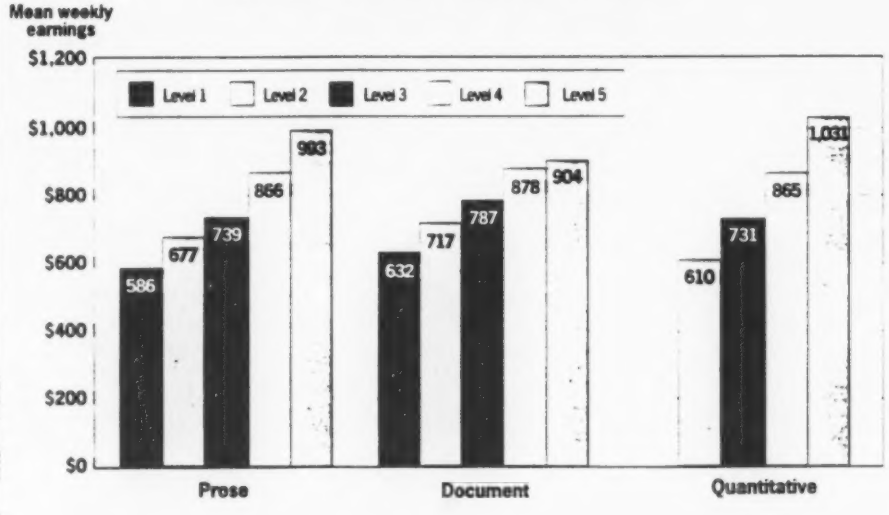
The effect of literacy on earnings, however, is not simply the result of variations in education. Some differences in average earnings by literacy level exist even within categories of educational attainment. For example, college graduates with a level five proficiency on any scale have greater earnings than college graduates with a level two proficiency on the same scale (figure 5.4). For the prose scale, college graduates in level five earn $993 per week compared with $677 per week for college graduates in level two—a difference of 47 percent. Sum (forthcoming) also conducted extensive regression analysis of the impact of literacy on employment and earnings outcomes. His findings demonstrate that literacy has both positive direct and positive indirect effects on employment and earnings. The indirect effect occurs because individuals with higher literacy tend to acquire higher education, which leads to more stable employment and higher earnings. But individuals with higher literacy also have more favorable employment and earnings outcomes even after controlling for their education level.

Figure 5.4
Mean weekly earnings of full-time employed college graduates, by proficiency level on three literacy scales: 1992



NOTE: No figure is available for quantitative literacy level 1 because there are too few college graduates in level 1 on the quantitative scale to generate reliable estimates.

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

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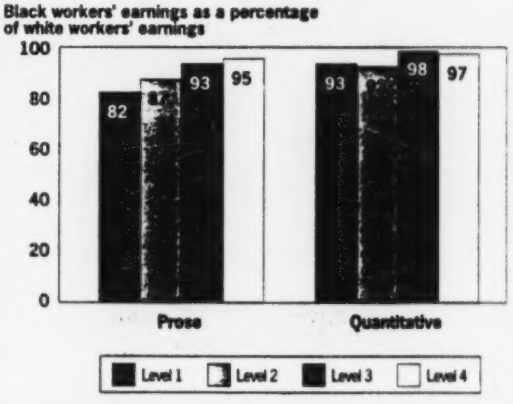
Figure 5.5
Weekly earnings of full-time black workers as a percentage of white workers' earnings, by literacy proficiency level: 1992



NOTE: No figures are available for literacy level 5 because there are too few cases to provide reliable estimates.

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

Enhanced prose and quantitative literacy could be an important ingredient in any prospective improvement in the economic condition of black workers compared with white workers. In the aggregate, black workers earn significantly less than white workers. Mean weekly earnings among black workers in the 1992 NALS sample were $425 or 73 percent of the $582 earned by white workers. But the differences in earnings were smaller among individuals at the same quantitative and prose proficiency levels. For instance, in terms of quantitative literacy, the mean weekly earnings of black workers ranged from 92 to 98 percent of those of whites, depending on the proficiency level (figure 5.5).

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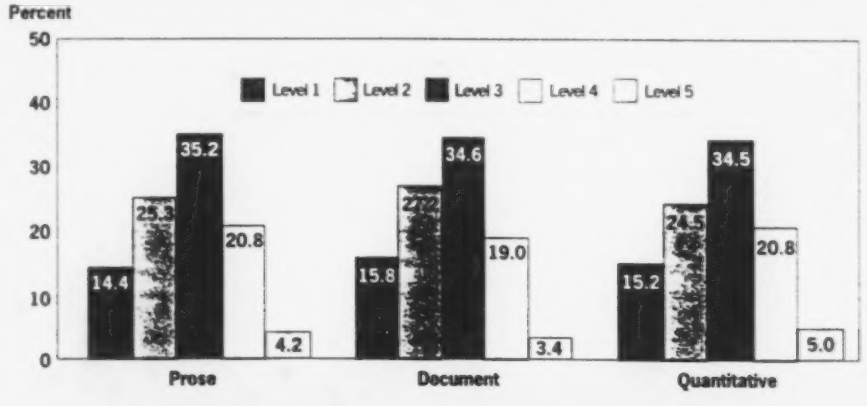
INDICATOR 11

Literacy Levels of the Labor Force and New Job Entrants

Indicators 9 and 10 clearly demonstrate that literacy is strongly related to individual success in the labor market. Given this relationship, it is disappointing to find that the literacy proficiency of a substantial proportion of the U.S. labor force is limited. Approximately 40 percent or more of the adult labor force perform at the two lowest levels on each of the literacy scales (figure 5.6). For example, 43 percent of labor force participants perform at the two lowest document literacy levels—15.8 percent at level one and 27.2 percent at level two. This finding suggests that a substantial fraction of U.S. workers lack the skills needed to interpret, integrate, and compare or contrast information using written materials common to the home or workplace. These workers appear to be unable to perform the types of tasks typical of certain occupations that demand high skills, such as professional, managerial, technical, high-level sales, skilled clerical, or craft and precision production occupations.

While a large proportion of the U.S. labor force has limited literacy skills, only a small proportion of the labor force performs at the highest literacy levels. For each literacy scale, 5 percent or fewer of labor force participants score in the highest proficiency level, demonstrating an ability to perform well on a wide array of literacy tasks.

Figure 5.6
Percentage of labor force in each proficiency level on the three literacy scales: 1992



SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

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Given the positive relationship between literacy and success in the labor market, increases in literacy should contribute to the productivity of U.S. workers. To examine recent trends in literacy among U.S. workers, we compared the literacy scores of respondents in the 1992 NALS and the 1985 NAEP Young Adult Literacy Survey (YALS).

Findings from these studies suggest that the literacy levels of young adults from ages of 21–25 years may have declined in recent years. Adults in this age range, most of whom are current or soon-to-be job entrants, performed less well in 1992 than the comparable group in 1985 (table 5.1). In addition, the cohort of adults who were ages 21–25 years in 1985 appear to have had lower test scores in 1992, when they were ages 28–32 years, than they did in 1985.

Table 5.1
Average proficiency on literacy scales for young adults, by race–ethnicity: 1985 and 1992

PROSE

	Young Adult Literacy Survey - 1985 (ages 21–25)	National Adult Literacy Survey - 1992	
		(ages 21–25)	(ages 28–32)
Total	293	281	283
White	305	296	301
Black	248	256	251
Hispanic	251	231	223

DOCUMENT

	Young Adult Literacy Survey - 1985 (ages 21–25)	National Adult Literacy Survey - 1992	
		(ages 21–25)	(ages 28–32)
Total	292	281	281
White	305	296	300
Black	248	254	245
Hispanic	243	233	225

QUANTITATIVE

	Young Adult Literacy Survey - 1985 (ages 21–25)	National Adult Literacy Survey - 1992	
		(ages 21–25)	(ages 28–32)
Total	293	279	282
White	304	295	301
Black	252	244	240
Hispanic	253	229	223

SOURCE: U.S. Department of Education, National Center for Education Statistics, *Adult Literacy in America: A First Look at the Results of the National Adult Literacy Survey*, 1993a; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992; NAEP Young Adult Literacy Survey, 1985.

The influx of new immigrants in the late 1980s may have contributed to these patterns. Recent immigrants have much lower average scores as measured on the literacy scales than either the native-born population or immigrants who have lived

in the United States for more than 10 years. Among employed respondents to the 1992 NALS, the mean scores of recent immigrants were 25–30 points below the scores of other foreign-born respondents and 89–92 points below the scores of native-born respondents. The influx of immigrants from 1985 through 1992 is reflected in the increase in the proportion of the population that is Hispanic.

These findings on the apparent decline in literacy should be interpreted cautiously for at least two reasons. First, the data provide only two observation points. Further observation points are necessary to establish a trend in literacy. Second, the procedural differences in the application of the NALS and YALS may make comparisons difficult. A reevaluation of the NALS and YALS data is currently being conducted by NCES and the Educational Testing Service. Preliminary estimates suggest that after controlling for procedural differences between the NALS and YALS, the estimated decline in literacy may be smaller than originally indicated and possibly insignificant.

Conclusions

- ***Workers with higher literacy earn more and experience less unemployment than workers with lower literacy. Differences in unemployment and earnings by literacy level exist even within broad categories of educational attainment.***

- ***Literacy appears to account for a large proportion of the earnings differences between black and white workers. Within the same proficiency level, black workers earn nearly as much as white workers.***

- ***The literacy proficiency of a substantial proportion of the U.S. labor force is limited, and only a small proportion of workers perform at a high literacy level. These findings suggest that many U.S. workers are unable to perform the types of tasks that are typical of occupations that demand high skills.***

- ***Literacy levels of young adults may have declined from 1985 through 1992. However, because we have data for only two points in time and the data may not be comparable, we cannot conclude definitively that literacy is declining.***

CHAPTER 6

The Role of Occupations in the Education-Earnings Link

Workers with higher levels of educational attainment and literacy may have higher earnings and greater employment stability in part because their educational advantage gives them access to occupations in which they can maximize their productivity and receive more generous compensation. Workers with low levels of education and literacy, for the most part, are shut out of these occupations. In this chapter, we examine trends in earnings, literacy levels, and educational attainment by occupation. Our findings show that occupations which are expanding most rapidly and in which earnings are highest also tend to have the most educated and literate workers. Although high education and high literacy may not be essential for a worker to move into these occupations, our findings suggest that entrants into these occupations must compete against a highly educated, highly literate group.

INDICATOR 12

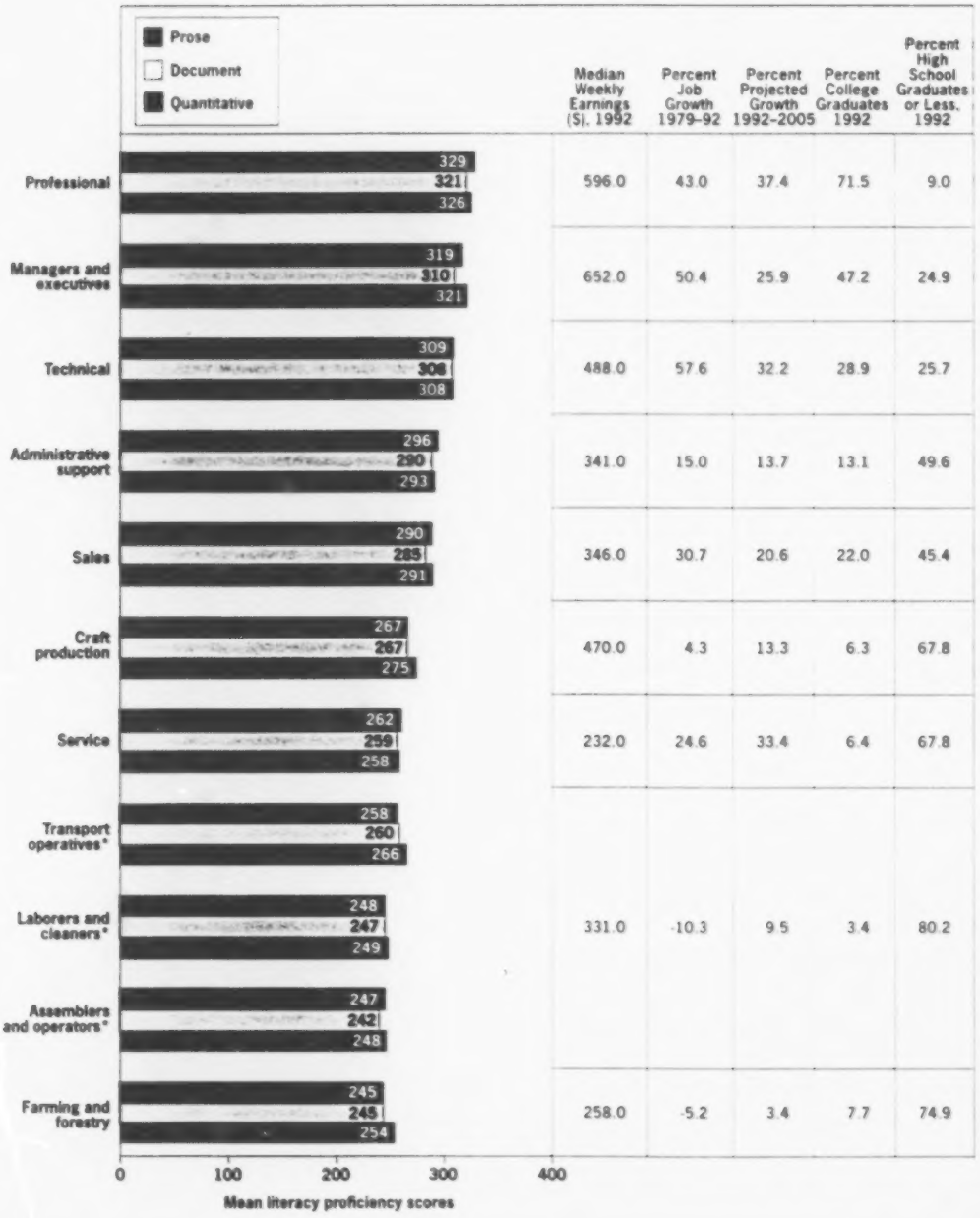
Education and Literacy of Workers by Occupation

Employment generally is growing fastest in the occupations that have workers with relatively high education levels and high literacy skills. Of the 11 occupational groups shown in figure 6.1, the three groups with the highest proportion of college graduates are professional workers, technical workers, and managers and executives. Workers in these same three occupational groups also have the highest average literacy scores. Employment growth in these high-education, high-literacy occupations was also strong. Employment growth in each was 40 percent or greater from 1979 through 1992. Relatively strong employment growth is expected to continue in these occupations, with projected increases in each of at least 25 percent from 1992 through 2005 according to the Bureau of Labor Statistics. In some occupations with less-educated, less-literate workers—farming, forestry, and fishing, and the combined occupations of transportation, laborers, and operators—employment declined from 1979 through 1992 and is projected to grow by less than 10 percent from 1992 through 2005.

Occupations dominated by workers with substantial education and literacy also tend to be high-paying occupations. Median weekly earnings in the professional and managerial categories, for instance, are nearly twice the median for occupations with less than 10 percent college graduates and the lowest average literacy levels, with the exception of craft production. Services, the one fast-growing occupation dominated by less-educated, less-literate workers, has the lowest median earnings of all the occupations shown in figure 6.1.

The relationship between literacy, education, and access to occupations is illustrated by the education and proficiency characteristics of workers in the highest- and lowest-paying occupations. The characteristics of workers in the highest-paying occupations (professional, managerial, and technical) are reflected in table 6.1. The table shows the proportion of workers at each literacy and education level who hold a job in one of the highest-paying occupations. Workers in the highest-paying occupations tend to have both high literacy and high education levels. Nearly 83 percent of workers with a college degree and the highest level of prose literacy have a job in one of the highest-paying occupations. The proportion of workers in these occupations drops to 46 percent for college graduates at the lowest level of prose literacy. Literacy is therefore associated with access to these jobs, even holding educational

Figure 6.1
Job growth and characteristics of workers, by occupation



*Separate data are not available for transport operatives, laborers and cleaners, and assemblers and operators. The data for these categories are shown as a group.

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; George T. Silvestri, "Occupational Employment: Wide Variations in Growth," *Monthly Labor Review* (November 1993): 58–86; U.S. Department of Education, National Center of Education Statistics, National Adult Literacy Survey, 1992; U.S. Department of Commerce, Bureau of the Census, Current Population Survey, 1992.

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attainment constant.[40] A similar point is true of variations in education: workers with higher educational attainment are more likely to be in the highest-paying occupations, even holding literacy constant. These findings suggest that both literacy and education contribute to an individual's ability to obtain a job in the highest-paying occupations.

Table 6.1
Percent of employed 22- to 65-year-olds holding professional, managerial, or technical jobs, by educational attainment and proficiency level on the prose scale

Educational attainment	Proficiency level					All proficiency levels
	1	2	3	4	5	
0 to 8 years	2.0	5.5	5.5	38.7	*	3.0
9 to 12 years, no diploma or GED	2.0	4.7	6.2	11.0	*	4.2
High school diploma or GED	5.6	8.5	9.7	12.4	15.2	9.1
Some college, no degree	8.8	16.8	21.3	29.0	43.9	22.1
Two-year degree	27.6	29.1	36.8	43.2	40.0	37.7
Four-year degree or higher	46.1	56.2	64.3	74.9	82.7	71.0
All educational attainment levels	5.3	13.5	26.1	49.9	71.8	27.4

*Too few cases to provide reliable estimates.

NOTE: The number shown in each cell is the proportion of workers with the indicated proficiency and education levels who hold professional, managerial, or technical jobs. For example, 2 percent of workers with 8 years or less of schooling and at prose proficiency level one hold professional, management, or technical jobs.

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

[40]The relationship between jobs and literacy may also exist, in part, because jobs affect literacy; that is, workers who stay in certain occupations may increase their level of prose proficiency over time

Increased literacy and education also decrease the probability that workers hold jobs in the lowest-paying occupations (service, laborers/helpers/cleaners, and farming/fishing/forestry). Only 2.3 percent of college graduates with the highest proficiency in prose hold jobs in the lowest-paying occupations (table 6.2). In contrast, nearly 50 percent of those individuals with the lowest proficiency and education levels work in these lowest-paying occupations. A worker who has not completed high school and has a level two proficiency or less in the prose category has at least a 40 percent chance of being in one of the lowest-paying occupations. This is nearly double the percentage of the full population that is in these occupations.

Table 6.2
Percent of employed 22- to 65-year-olds holding service, laborer/helper/cleaner, or farm/forestry/fishing occupations, by educational attainment and proficiency level on the prose scale

Educational attainment	Proficiency level					All proficiency levels
	1	2	3	4	5	
0 to 8 years	49.0	41.5	38.4	23.7	*	46.6
9 to 12 years, no diploma or GED	42.5	39.9	34.4	28.1	28.5	39.3
High school diploma or GED	44.4	30.5	25.1	19.3	8.2	28.9
Some college, no degree	39.6	24.6	19.1	15.0	9.1	20.2
Two-year degree	19.9	14.2	13.5	11.6	10.5	12.9
Four-year degree or higher	11.2	7.3	7.5	4.6	2.3	5.5
All educational attainment levels	43.5	29.4	19.5	10.5	4.0	22.6

*Too few cases to provide reliable estimates.

NOTE: The number shown in each cell is the proportion of workers with the indicated proficiency and education levels who hold service, laborer/helper/cleaner, or farm/ forestry/fishing jobs. For example, 49 percent of workers with 8 years or less of schooling and at prose proficiency level one hold jobs of this kind.

SOURCE: Andrew Sum, *Literacy and the Labor Force: Results of the National Adult Literacy Survey*, forthcoming; U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, 1992.

DISCUSSION: JOB SKILLS MISMATCH

The issue of a mismatch between the skills demanded by U.S. employers and those offered by workers has been hotly debated. The *Workforce 2000* study sponsored by the U.S. Department of Labor popularized the idea that, as we approach the year 2000, U.S. producers will encounter an insufficient supply of professional, technical, and managerial workers and an oversupply of less-skilled workers. The primary cause of this trend is technological change, which researchers and policymakers argue requires more highly skilled labor than was needed in the past. This trend is reflected in the statistics presented in the previous section, which demonstrated that occupations with the greatest growth are those in which workers are most highly educated. Based on this prediction, researchers and policymakers have argued that the current and future work force will need to be better educated and more highly skilled if U.S. producers are to have access to the labor needed to exploit new technologies, maintain productivity and wage growth, and compete effectively in international markets. Bishop (1992) argues that based on current projections of skill shortages, public policy should be used to stimulate a substantial increase in the supply of college graduates. Cappelli (1996) presents findings based on the EQW establishment survey suggesting that changes in the workplace and adoption of new technologies are increasing skill requirements even among production workers.

Not all researchers are convinced by the arguments in *Workforce 2000* and the projections of shortages of skilled labor. Mishel and Teixeira (1991), for example, argue that contrary to the *Workforce 2000* projections of increased skill requirements, the trend toward higher-skilled occupations will slow down in the future. In addition, they argue that "up-skilling" within occupations due to technological change does not appear to be widespread. Mishel and Teixeira (1991) conclude that the prediction of a skills shortage has tended to overstate the growth in professional and technical jobs, and led to an overemphasis on college education. They assert that the more important challenge is to improve the jobs, pay, and skills of the noncollege-educated work force.

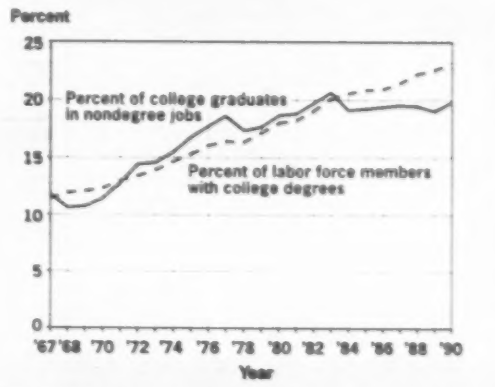
Regardless of the changes in the aggregate demand for skills, the issue faced by workers is whether, given the wage structure, it is to their advantage to seek greater skills. The increased wage premium paid to college graduates discussed in chapter 3 clearly implies that the economic returns to college education are increasing. Such an increase in returns is a direct indication that demand for college graduates has increased more rapidly than supply in recent years. The increase in returns also suggests that expansion of college education is probably still a valuable investment, despite the argument made by Mishel and Teixeira (1991) that there is already an overemphasis on college education. Even if low-skill jobs are readily available, the average worker is likely to continue to need higher skills and more education to increase productivity, compete for desirable jobs, and expand his or her earnings potential.

INDICATOR 13

College Degrees and Employment in College Jobs

Despite the increase in earnings for college graduates relative to other workers, some researchers have expressed concern about the types of jobs being taken by college graduates. The proportion of college graduates holding jobs that traditionally have been held by workers without a college degree has increased over the past two or three decades (figure 6.2).[41] From 1967 through 1990, the rate at which college graduates held "noncollege" jobs increased from 10 to 20 percent. This trend has been interpreted by some as an indication that there is an excess supply of college graduates and that they are being forced to take jobs that do not require a college education (Hecker 1992).

Figure 6.2
College graduates in the labor force and in jobs that do not require college degrees: 1967–90



NOTE: Unemployed graduates are counted as college graduates in nondegree jobs. Data refer to the noninstitutionalized population ages 16 years and older.

SOURCE: Daniel H. Hecker, "Reconciling Conflicting Data on Jobs for College Graduates," *Monthly Labor Review* (July 1992): 3–12; U.S. Department of Commerce, Bureau of the Census, Current Population Survey.

The increase in the number of college graduates in traditionally noncollege jobs does not imply, however, that students are unwisely investing in a college education. The phenomenon is probably inevitable given the large increase in the proportion of workers with college degrees over the past two or three decades. The share of the labor force that graduated from college increased from 12 percent to 23 percent over the period shown in figure 6.2. For all the new college graduates to have been employed in jobs traditionally held by college graduates, the number of these jobs would have needed to grow at a similar rate and represent a much larger proportion of all jobs. Such changes in employment did not occur. However, the increase in the number of college graduates indicates that employers found ways to use these graduates productively in "noncollege" jobs. At the

[41] Our treatment of jobs follows Hecker (1992). Jobs traditionally held by college graduates include those in managerial, professional, sales representative, or technician occupations. They are also traditionally employed as police officers, blue-collar worker supervisors, farm managers, or senior-level administrative support workers. Jobs traditionally held by nongraduates include those in retail sales, administrative support, service, precision production, farming, and craft and repair. They are also traditionally employed as operators, fabricators, and laborers.

same time, the increasing returns to education suggest that college graduates continued to be rewarded for their educational investment, even as more of them moved into these "noncollege" occupations, which suggests that these occupations may have changed in such a way as to use college-educated workers efficiently.

The rapid increase in college graduates may have also diluted, to some extent, the average "quality" of college graduates as more students of lesser ability are drawn into college. This would be likely to contribute to an increase in the proportion of college graduates holding traditionally noncollege jobs. Students with limited abilities even after having completed a college education may not qualify for jobs that traditionally have been held by workers with a college degree. Therefore, more graduates taking noncollege jobs is not necessarily a negative indicator of the market for college graduates. Rather, the critical question in terms of productivity is whether college graduates who take noncollege jobs are more productive having attended college than they would have been had they not attended college, regardless of their occupation. Findings of wage differentials between college graduates and other workers within the same occupation suggest that this may be the case.[42]

Conclusions

■ ***Occupations that have the greatest recent job growth and highest earnings are those in which employees have the most education.***

■ ***High-paying, high-growth occupations also are filled with high-literacy workers. Workers with limited education or limited literacy are generally shut out of the best-paying occupations.***

■ ***An increasing number of college graduates now hold jobs traditionally held by workers without college degrees. But this is not an indication that students are making unwise investments in higher education. On the contrary, the returns to college education have increased over time, even as more graduates take jobs in these other occupations.***

[42]This argument is made by Alsalam (1993) and is supported by data presented in Tyler, Murnane, and Levy (1995).

CHAPTER 7

Training of Labor Force Participants

Education clearly has a role in building human capital by making students more productive workers. As a general investment in human capital, education tends to raise an individual's ability to succeed in the labor market in general, as opposed to raising productivity in a specific job or occupation. Although most workers complete their formal education before joining the labor force, the investment in human capital does not end at that time. Through training, many workers continue to improve their skills throughout their lives. Training can be formal or informal. Formal training would include school programs, such as those at a high school or postsecondary institution, or special company programs to improve a specific set of skills. Informal training would include on-the-job training that often occurs at the beginning of a job or work assignment. This may involve self-study or learning through developmental assignments. Compared with education, training tends to represent a more specific investment in human capital—it is usually intended to develop particular job skills or increase productivity in a particular task, job, or occupation.

It has been argued that U.S. workers are less skilled than European and Japanese workers, partly because U.S. workers do not have the same access to training as workers do in other countries.[43] On the basis of this alleged deficiency in U.S. training, researchers have argued that the United States must expand work force training in order to compete internationally (U.S. Department of Labor 1989) or to reverse a perceived slowdown in the growth of worker productivity in the United States since the early 1970s (Goldstein 1980). But an expansion of training can only have an impact on productivity growth if training has a positive impact on the productivity of individual workers. One objective of this chapter is to investigate the relationship between training and individual productivity. The other objective is to examine the extent of training of U.S. workers and the characteristics of those who receive training.

Two indicators are presented in this chapter. The first addresses the relationship between training and the productivity and earnings of individual workers. As in previous chapters, we focus on earnings of individual workers as a proxy

[43] U.S. Congress (1990) and Lynch (1993) discuss the training of U.S. workers compared with workers in other countries.

for productivity. The data used for this indicator are drawn from the 1991 Current Population Survey (CPS) training supplement, which was used to gather information on the training experiences of workers across the United States. We also discuss estimates from the most recent econometric studies of the impact of training on earnings and productivity.

The second indicator measures the prevalence of employment-related training in the United States. Using data from the 1991 CPS and the 1991 National Household Education Survey (NHES), we measure rates of participation in training among U.S. workers in 1991. We also use CPS data from 1983 and 1991 to examine the trends in training participation in the United States between these two years. Finally, we examine the training rates by education level and occupation.

INDICATOR 14

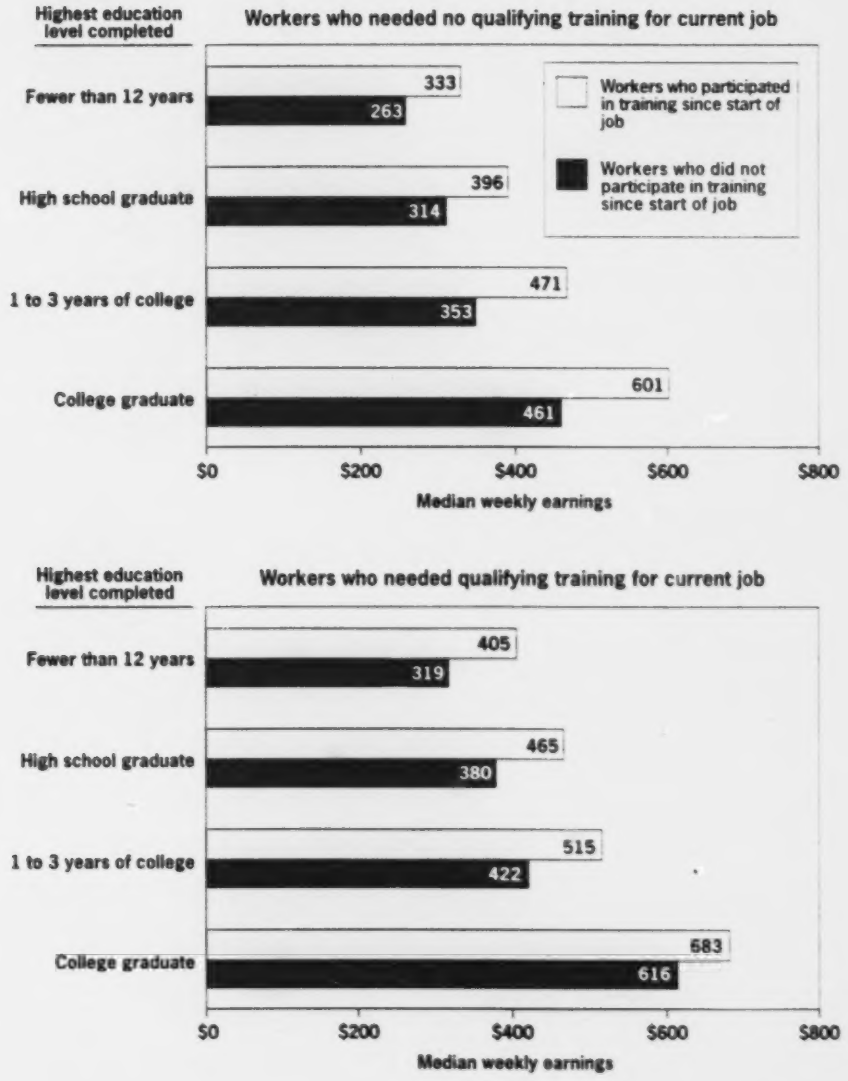
Training and Earnings

The economic theory of the accumulation of human capital argues that individual workers can use training to increase their productivity, which in turn will increase their earnings as they become more valuable to employers. This section compares average earnings of two groups of workers—those who participated in training on their current job and those who did not.

Data on average earnings from the 1991 CPS training supplement suggest that participation in skill improvement training is positively related to the earnings of workers (Eck 1993). Figure 7.1 shows results for two groups—one group that needed qualifying training for their current job and the other group that needed no qualifying training. Within these two groups and within four broad education categories, the figure shows the median weekly earnings for workers who participated in training since they were hired in their current job and for workers who did not participate in training since they were hired. Within each of the education classifications, earnings in 1991 were higher for workers who participated in skill improvement training while on their current job than for those who did not. In percentage terms, the lowest difference in earnings in figure 7.1 is 11 percent ($683 per week for trainees compared with $616 for nontrainees) for college graduates in jobs with qualifying training. The largest difference in earnings is 33 percent ($471 for trainees compared with $353 for nontrainees) for workers with one to three years of college who are in jobs not requiring qualifying training.

The earnings differences between trainees and nontrainees presented in figure 7.1 are probably biased estimates of the effect of training on earnings because trainees and nontrainees differ in ways that affect their relative earnings but that are not controlled for in the calculations of figure 7.1. For example, trainees may earn more simply because they are in higher-paying occupations than nontrainees (a similar point is addressed in chapter 3 in the discussion of Indicator 4 and the impacts of education on earnings). In addition, the phrasing of the training question in the CPS, which refers to any training since the start of the current job, implies that trainees are likely to have longer average tenure than nontrainees with their current employer. This is true because workers with longer tenure have had more time to participate in training since the start of their current job, so the probability of having participated in training at the current job is greater for workers with longer tenure. Since tenure has been shown to be positively related to earnings, the tenure differences may explain why trainees earn more than

Figure 7.1
Median weekly earnings of full-time workers ages 16 years and older, by training status and educational attainment: January 1991



SOURCE: Alan Eck, "Job-Related Education and Training: Their Impact on Earnings," *Monthly Labor Review* (October 1993): 21–38; U.S. Department of Commerce, Bureau of the Census, Current Population Survey, January 1991.

nontrainees. Of course, observable differences between trainees and nontrainees, such as differences in average tenure, could be controlled for in a regression analysis. But some differences between trainees and nontrainees may not be observable. For example, trainees may be more "motivated" than nontrainees.

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Such differences might suggest that the trainees would earn more than nontrainees even without having participated in training. It would be a mistake in this case to attribute all of the earnings difference to the impact of training.

More sophisticated estimates of the impact of training on earnings, which attempt to control for the observed and unobserved differences between trainees and nontrainees, tend to show that training on the current job does have a positive impact on wages. Using longitudinal data on men from the NLSY, Lillard and Tan (1992) show that in the first year after training, training is associated with an 11.9 percent increase in earnings. In subsequent years, this effect decreases by 1.1 percentage points per year so that the net effect of training drops to zero by the eleventh year after training. In terms of source, training from the company had the largest effect on post-training earnings (16 percent), followed by training from business and vocational schools (11 percent), and regular school and other sources (8 percent).[44] The rates at which these effects decreased over time is similar across sources.[45]

Blanchflower and Lynch (1994) also present evidence that formal training has a positive impact on earnings. Using a sample of 25-year-old noncollege graduates (from the NLSY), they show that training provided by the current employer increases hourly earnings by an estimated 8 percent, while training provided by a previous employer has little effect on earnings.[46] Participation in off-the-job training increases hourly earnings by 4 percent, while participation in an apprenticeship increases hourly earnings by 19 percent. These findings support those of Lynch (1992), which also show that training provided by the current employer has a positive effect on earnings. Lynch (1994) cites two other studies (Mincer 1988; Holzer 1989) that found positive effects of formal training on hourly earnings of about 4 or 5 percent. Another recent study conducted by Bartel (1995) shows that workers at a large manufacturing company who participated in formal training at the company had much higher earnings than nontrainees. Bartel (1995) estimates a rate of return to training of 26 to 58 percent, depending on the assumed rate of depreciation. Finally, findings from both Lynch (1992) and Bishop (1994) confirm that training from a previous employer has little effect on current earnings.

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[44]The NLSY does not explicitly ask about informal on-the-job training.

[45]Lillard and Tan (1992) also find that training is associated with a decrease in the likelihood of unemployment, and that this effect persists for approximately 12 years after training. Company training is associated with the greatest reduction in the likelihood of unemployment.

[46]These findings are based on regression estimates of hourly earnings equations. Blanchflower and Lynch (1994) also report the results for estimated wage difference equations, which imply somewhat higher effects of training on hourly earnings.

Evidence about particular types of training indicates that basic skills training may be positively associated with earnings. Using data from the NHES, Hollenbeck (1993) finds that participation in basic skills training in the 12 months prior to the interview generates a 19 percent increase in annual earnings for men. However, the same training had no significant impact on women according to the NHES data. The findings for men and women are reversed when Hollenbeck examines data from the CPS. Based on these data, participation in basic skills training since the start of the current job increases weekly earnings by 14 percent for women but has no significant impact on men. Hollenbeck provides several potential explanations for the discrepancy in findings from the two data sources. For example, the two data sources use different earnings and training measures—NHES data are based on annual earnings and training occurring in the 12 months prior to the interview, while the CPS data are based on weekly earnings and training occurring since the start of the current job.

DISCUSSION: TRAINING AND PRODUCTIVITY

Because changes in earnings may not accurately reflect changes in productivity, estimates of the impact of training on earnings may either overstate or understate the impact of training on productivity. Researchers therefore recently have attempted to estimate the impact of training on productivity using data from company-based surveys, which can be used to derive direct measures of productivity.

Estimates generated from company-based data suggest that formal training has a substantial impact on productivity. Bartel (1994) and Bishop (1994) both find that formal training increases productivity. Bartel's study, which is based on a survey of U.S. manufacturing companies in 1986,[47] shows that businesses that implemented training programs from 1983 through 1986 experienced an estimated gain in productivity of nearly 19 percent over the three-year period.[48] The companies in the survey that implemented new training programs previously tended to lag behind comparable companies in terms of labor productivity in 1983. The impact of training allowed these companies to catch up to the productivity level of the other companies by 1986. Bishop's study, based on data from the Employment Opportunities Pilot Projects (EOPP), shows that

[47]Bartel (1994) used data from a 1986 Columbia Business School survey that covered 495 Compustat II business lines. The businesses surveyed are not a random sample of all U.S. businesses; no such random sample exists. Bartel, therefore, cautions that her findings may not be generalizable to all U.S. businesses.

[48]Bartel (1994) measures labor productivity at a business unit as net sales per employee in the unit.

company-sponsored training received on the job raises the productivity of newly hired employees by 16 percent.[49]

The effect of informal training, such as learning-by-doing, appears to be more limited than the effect of more formal training. Weiss (1994) used data on workers at three facilities operated by a telecommunications manufacturing company to evaluate productivity improvements among newly hired workers. His findings suggest that learning-by-doing does generate rapid growth in productivity among workers during the first month of employment—the median increase in productivity was between 11 and 45 percent at the three facilities.[50] However, this growth slows rapidly over the next few months and declines to zero by the sixth month on the job. He concludes that the overall effect of learning-by-doing on productivity is relatively small in the long run.

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[49]The productivity measure used by Bishop (1994) is based on the employer or supervisor rating (on a scale from 0 to 100) of an employee's productivity.

[50]In the Weiss (1994) data, productivity is measured according to an individual's physical output.

INDICATOR 15

Trends in Training Rates in the United States

Given that formal training appears to increase worker productivity and earnings, it is useful to consider the rates of training participation among U.S. workers and the trends in these rates. To measure training rates, we reexamine the data on skill improvement training from the 1983 and 1991 CPS training supplements. Training rates for different subgroups of workers and by source of training are shown in figures 7.2a and 7.2b. We also examine training rates by subgroups of workers (figure 7.3) based on data drawn from the 1991 NHES. These data differ from the CPS data in at least two important ways. First, the NHES asks about any employment-related training that occurred in the 12 months prior to the interview, while the CPS supplement asks about training at any time on the current job. Second, the NHES data refer to enrollment in formal training courses only, while the CPS data include participation in more informal on-the-job training.

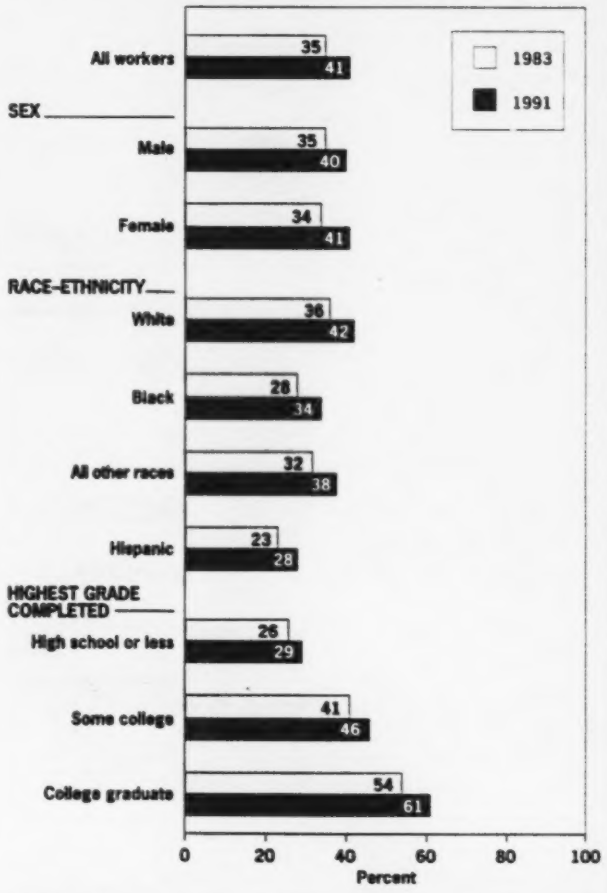
The CPS data suggest that the rate of training participation among U.S. workers increased between 1983 and 1991. In 1991, 41 percent of the work force had received skill improvement training on their current job, up from 35 percent in 1983 (figure 7.2a). Training rates increased for all of the gender and race-ethnicity subgroups shown in the figure. As shown in figure 7.3, NHES data reveal a lower training participation rate for 1991 (33 percent) than that found in the CPS, but this is to be expected because the NHES data do not include on-the-job training and reflect only training in the previous 12 months. Both the CPS and NHES data show that in 1991, training rates were similar for male and female workers, while white workers tended to receive more training than black or Hispanic workers.

Training is more prevalent among more highly educated workers than among other workers. According to the CPS data, 61 percent of workers in 1991 with a college degree participated in training on their current job, compared with 29 percent of workers with a high school education or less and 46 percent of workers with some college (figure 7.2a).[51] Data from the NHES also show that the probability of participating in training is correlated with education. Fifty-three percent of workers with a college degree participated in some job-related training in the previous year, compared with 38 percent of those with some postsecondary education, 22 percent of those with a high school diploma, and 9 percent of those who did not finish high school (figure 7.3).

[51]Lillard and Tan (1992) present empirical evidence confirming that the likelihood of getting most kinds of training rises with the level of educational attainment.

These findings either suggest that companies target training resources to their most educated workers or that more highly educated workers are more eager or willing to participate in training, possibly because they expect to realize a relatively high return from training. Recent research conducted by the Bureau of Labor Statistics suggests that workers with more education and greater aptitudes hold more complex jobs and are less likely to perform their duties adequately when they begin their jobs than workers with less education and lower aptitudes. Therefore, more educated workers appear to be in greater need of additional training to perform their duties, which may explain why receipt of training is positively correlated with educational attainment and test scores (U.S. Department of Labor 1996). Regardless of the reason for the positive correlation between education and training, it is clear that investments in training appear to complement investments in schooling. Training is not generally used to remedy the skill deficiencies of the less educated as compared with the more educated; rather, training tends to exacerbate the skill differences that already exist between workers with different educational backgrounds.

Figure 7.2a
All workers ages 16 years and older who participated in skill improvement training while on their current jobs, by sex, race–ethnicity, and educational attainment: 1983 and 1991 (percent of workers in each category)



NOTE: Hispanics may be of any race, and each of the racial categories includes Hispanics.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *How Workers Get Their Training: A 1991 Update*, 1992; U.S. Department of Commerce, Bureau of the Census, Current Population Survey, January 1983 and 1991.

Training also appears to be more common among workers in highly skilled occupations and is most common among professional, technical, and managerial occupations. According to the CPS data, workers in 1991 in all of these occupations had training rates in their current job of more than 50 percent (figure 7.2b). In contrast, no other occupation had training rates of more than 40 percent. The NHES data yield similar findings. About 56 percent of those working in a man-

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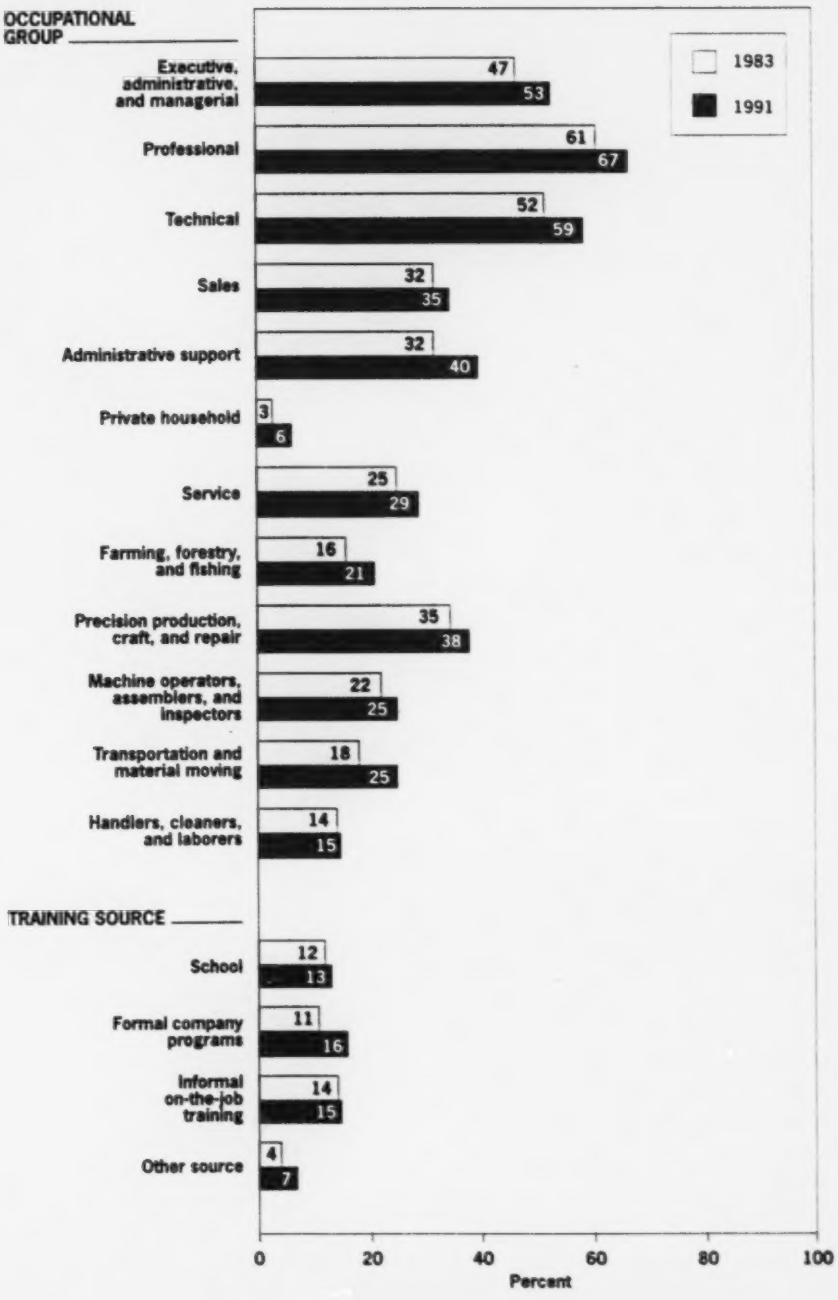
Figure 7.2b
All workers ages 16 years and older who participated in skill improvement training while on their current jobs, by occupational group and training source: 1983 and 1991
(percent of workers in each category)



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *How Workers Get Their Training: A 1991 Update*, 1992; U.S. Department of Commerce, Bureau of the Census, Current Population Survey, January 1983 and 1991.

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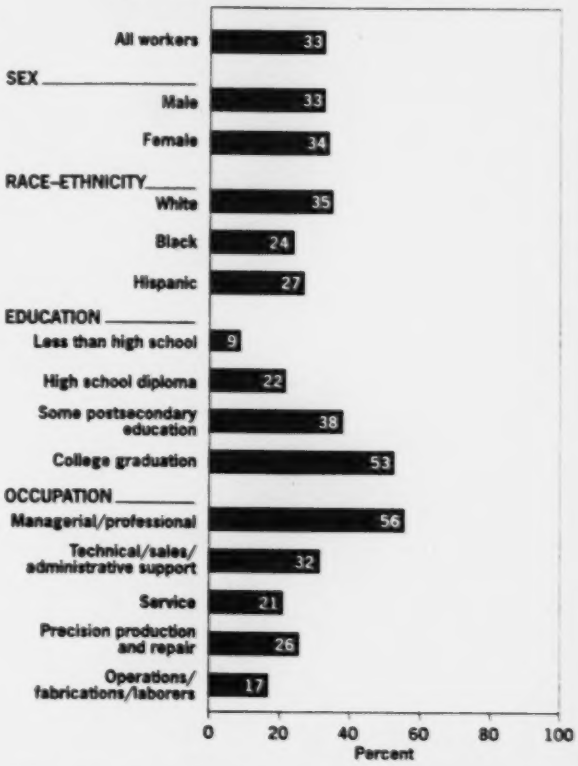
agerial or professional job had participated in training in the past 12 months, compared with substantially lower proportions of workers in the other four occupational categories shown in figure 7.3.

The relatively low rates of training for less-educated workers and for workers in less-skilled occupations have been used to argue that companies in the United States underinvest in their front-line workers (Barton 1993). According to this argument, recent changes in the economy have generated a greater demand for problem-solving skills, but front-line workers tend to lack these skills and have no obvious way to acquire them. Lillard and Tan (1992) present estimates suggesting that as the rate of technological change accelerates, there is likely to be even greater targeting of in-house training to more highly skilled, highly educated workers. Alternatively, if U.S. companies use a different skill mix or organize work differently than companies in other countries, the current training levels may be optimal.

Figure 7.3
Workers ages 17 years and older who were enrolled in employment-related training in the previous 12 months, by sex, race–ethnicity, education, and occupation: 1991 (percent of workers in each category)



NOTE: Employment status of individuals was determined by status during the week of the survey.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *Adult Education: Employment-Related Training*, 1994; U.S. Department of Education, National Center for Education Statistics, National Household Education Survey, 1991.

School programs, formal company training, and informal on-the-job training are all important sources of training according to reports from workers in the CPS training supplements. The incidence of training is about evenly divided among these three training sources (figure 7.2b). The rates of school training and formal company training are above average for workers in managerial, professional, and technical occupations. The rate of less formal, on-the-job training is evenly distributed across occupations.

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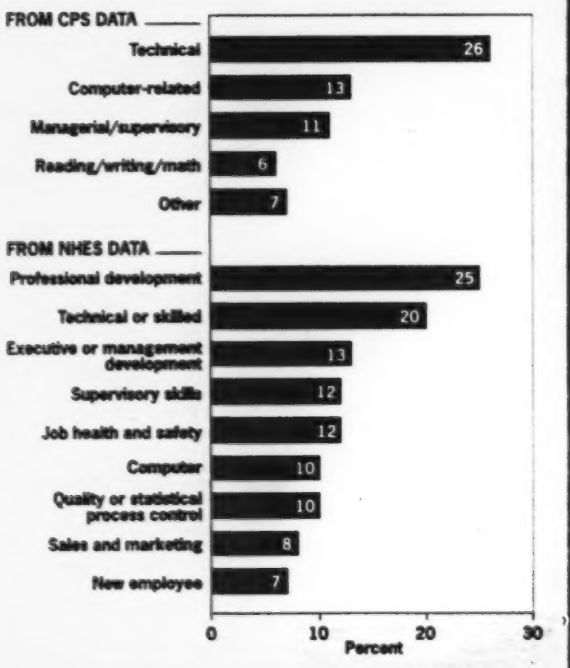
Figure 7.4
Training participation, by training type: 1991
(percent of workers participating in each type of training)



NOTE: CPS data include all employed individuals ages 16 years and older. NHES data include all employed individuals ages 17 years and older. CPS data refer to any training on the current job and NHES data to training in the last 12 months.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, *How Workers Get Their Training: A 1991 Update*, 1992; U.S. Department of Education, National Center for Education Statistics, *Adult Education: Employment-Related Training*, 1994; U.S. Department of Commerce, Bureau of the Census, Current Population Survey, January 1991; U.S. Department of Education, National Center for Education Statistics, National Household Education Survey, 1991.

Both the CPS and NHES include information on types, as well as sources, of training. The most common type cited in the CPS (figure 7.4) is occupation-specific technical training (26 percent), followed by computer-related training (13 percent), managerial or supervisory training (11 percent), and reading, writing, or math training (6 percent). The NHES categories are not the same as the CPS categories, although some are close. According to the NHES data (figure 7.4), in 1991, the most common type of training in the past 12 months for workers was professional development (25 percent), followed by technical or skilled job training (20 percent), executive or managerial development (13 percent), supervisory skills (12 percent), job health and safety (12 percent), computer and quality or statistical process control (both 10 percent), sales and marketing (8 percent), and new employee training (7 percent).

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CONCLUSIONS

■ *Participation in training is positively associated with earnings. Studies of the returns to training consistently show that formal employment-based training on the current job increases earnings. Studies that examine direct measures of productivity find that formal training also has a positive effect on productivity. However, more informal on-the-job training has a relatively small effect on productivity, according to at least one study.*

■ *A substantial proportion of U.S. workers reported participating in some type of training. Approximately 30 to 40 percent of workers reported in 1991 either that they participated in formal employment-related training in the previous 12 months or that they participated in formal or informal training since the start of their current job. Training rates increased between 1983 and 1991.*

■ *Training is most prevalent among the most highly educated workers and among workers in managerial, professional, and technical occupations, which require a high level of skills. Employment-related training in the United States therefore tends to contribute to the earnings advantage already enjoyed by highly educated, highly skilled workers.*

CHAPTER 8

International Trends in Education

According to the findings presented in chapter 2, worker productivity in other industrialized countries is increasing at a faster rate than in the United States, and these countries are therefore slowly catching up to the United States. Furthermore, although factors other than education (for example, physical capital) are important to economic productivity, education appears to play a substantial role in determining productivity. In fact, throughout this report, we have shown a link between economic productivity and various measures of education, including attainment, achievement, literacy, and training. The next step in our examination of education and economic productivity is to explore how the United States compares with other countries in these specific measures of education.

This chapter presents four sets of indicators to compare education and skill training in the United States and other industrialized countries: measures of educational attainment in industrialized countries, the international distribution of educational achievement, adult literacy in industrialized countries, and training rates in industrialized countries.

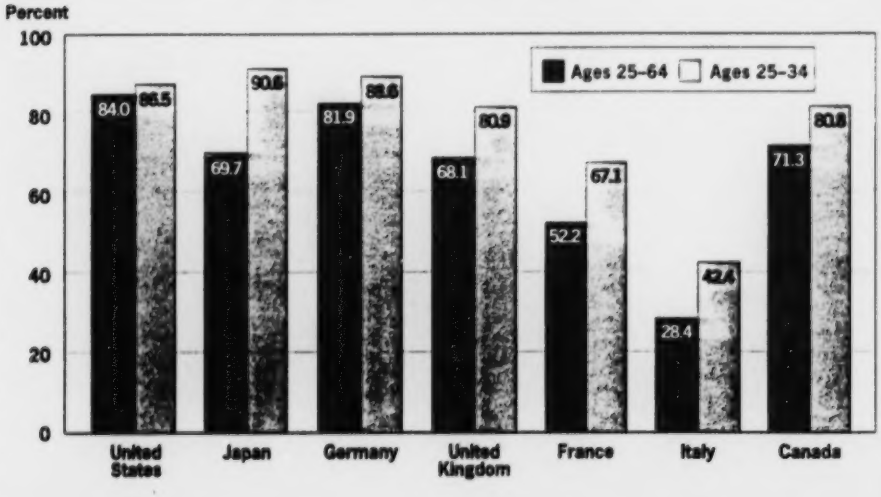
INDICATOR 16

Educational Attainment in Industrialized Countries

Evidence on productivity convergence brings to light two considerations central to an examination of the level of education in and between nations. First, it is necessary for countries to have a level of education that is roughly comparable to that in the leader country in order to benefit from the leader country's technical knowledge (see discussion in chapter 2). Second, analysis of productivity in a broad sample of countries suggests that a high rate of secondary education is especially important in enabling countries to be among the world leaders in worker productivity. A large proportion of the population in countries with productivity converging on that of the United States has completed or is enrolled in secondary education (Barro 1991; Baumol, Blackman, and Wolff 1989). There is less evidence about the importance of college education for determining relative productivity among countries. However, substantial evidence of the connection between college education and productivity at the individual level (chapter 3) suggests that rates of college education may also be important determinants of cross-country differences in worker productivity. These considerations raise the issue of how levels of attainment among the industrialized countries known as the G-7 (United States, Japan, Germany, United Kingdom, France, Italy, and Canada) compare to one another.

Although the percentage of the adult population ages 25–64 years that has completed secondary school varies across countries, the evidence shows that nations are closing the gap with the United States at the secondary level. More than 80 percent of the adult population ages 25–64 years in both Germany and the United States have finished the equivalent of a high school education (figure 8.1). The trend among the youngest workers, however, is for the other countries to converge on—and in some cases overtake—the leader's level in secondary attainment. Japan, Germany, the United States, the United Kingdom, and Canada all educate between 80 and 90 percent of their young adults ages 25–34 years through high school completion. Furthermore, in countries other than the United States, the attainment gap between the oldest and youngest age groups is larger than in the United States, indicating that attainment is increasing more rapidly in the other countries. This is due, in part, to the fact that older workers in most of these countries have a much lower level of attainment than older workers in the United States. The convergence of secondary education completion rates in G-7 countries is likely to be one of the factors contributing to the convergence of worker productivity in these countries.

Figure 8.1
Secondary school completion, by age: 1992



NOTE: In the United States, completing secondary school is defined as graduating from high school or earning a GED.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*; Organization for Economic Cooperation and Development, Indicators of Education's Systems, *Digest of International Education Statistics*, forthcoming.

Most G-7 countries still lag well behind the United States in postsecondary attainment. The United States has by far the highest proportion of the population ages 25–64 years that has completed a college education, as shown in figure 8.2. But the rate of college completion among young adults in the United States has risen very slowly over the past 20 years, and according to the data in figure 8.2, the rate of college completion among adults ages 25–34 years is slightly lower than for adults ages 25–64 years. The rate of college completion for the youngest cohort of adults in most of the other countries is only slightly higher than for all adults ages 25–64 years. The one exception is Japan, in which the rate of college completion among the adult population is rapidly increasing. By 1992, approximately 23 percent of Japanese adults ages 25–34 years had completed a college-level education, the same as U.S. adults in the same age range. These findings suggest that, to date, G-7 countries other than Japan have placed less emphasis on increasing the share of their population with this high level of education. This finding generally holds true even when college completions are combined with completions in nonuniversity postsecondary programs (figure 8.3).

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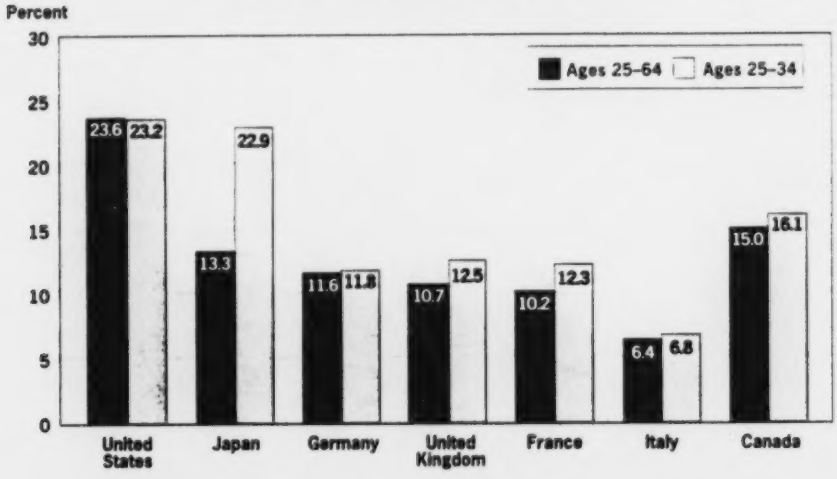
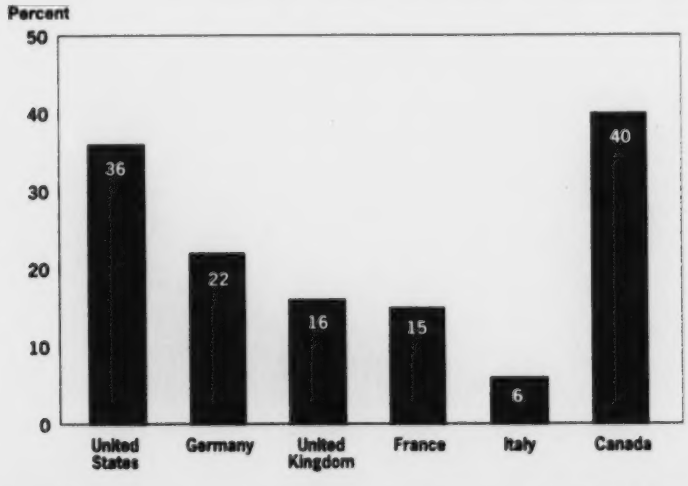
Figure 8.2
Completion of higher education, by age: 1992



NOTE: In the United States, completing higher education is defined as earning a bachelor's degree.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1995*; Organization for Economic Cooperation and Development, Indicators of Education's Systems, *Digest of International Education Statistics*, forthcoming.

Figure 8.3
Completion of postsecondary education, percent of population ages 25–64 years: 1991



NOTE: Postsecondary education includes university and nonuniversity education above the secondary level. Completion of postsecondary education is defined according to the International Standard Classification of Education, which is used as a means of compiling internationally comparable statistics on education. Postsecondary completion includes education at the postsecondary level which leads to an award or degree. The classification is described in detail in Annex 4 of Organization for Economic Cooperation and Development (1993). In the United States, completion of postsecondary education refers to high school graduates who complete programs at a technical or vocational institution, a two-year college, or a four-year college or university.

SOURCE: Organization for Economic Cooperation and Development, *Education at a Glance*, 1993.

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INDICATOR 17

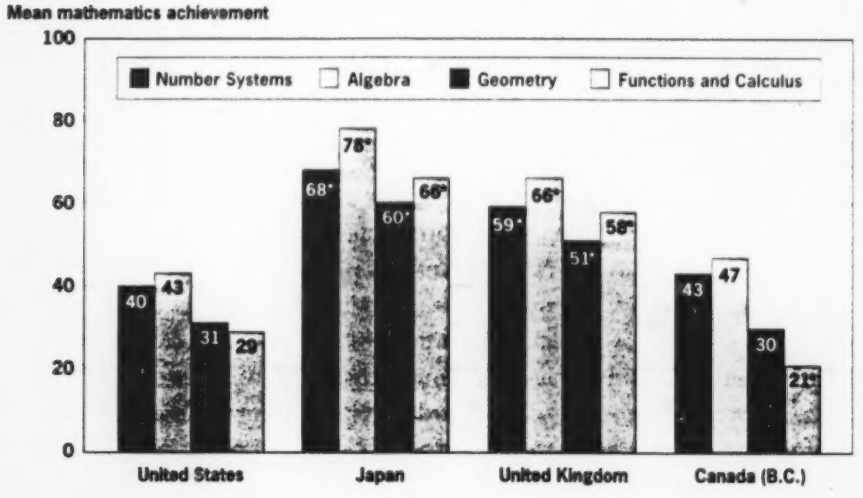
Educational Achievement in Industrialized Countries

Education attainment levels are merely an indication of the mix of skills and knowledge shared by populations in different countries. Consequently, many observers question whether the increase in the level of attainment in the United States over the past 30 to 40 years represents an increase in people with the skills and knowledge necessary to sustain economic productivity. Unfortunately, addressing this concern is difficult for a number of reasons. Among the most important is the dual problem of determining the kinds of skills and knowledge that lead a country to higher levels of productivity, and obtaining agreement on the mix of skills that should be measured across similar populations in different countries. Furthermore, because of differences in the selective educational tracks in different nations, identifying comparable groups of students is also a challenge. This issue has created a tendency in international assessments of student performance to concentrate on younger populations that have not been subjected to selective educational practices. But skills at these younger ages are far from the point at which they would influence productivity in the workplace. In addition, most international studies compare students at a single point in time, and when the assessments are repeated over time, they tend to include a changing cast of countries. Consequently, it is problematic to make comparisons that indicate whether U.S. students have changed their performance relative to students in other countries over time.

Despite these limitations, it is clear from the existing data that the United States is typically not the leader nation in average student achievement among G–7 countries in mathematics and science. In the early to mid-1980s, the average mathematics and science scores of U.S. students in their last year of secondary school were generally lower than those of students at a similar level of education in other G–7 countries (figures 8.4 and 8.5). The mean scores of students in Japan and the United Kingdom were consistently higher than those of U.S. students in the various mathematics and science areas presented in the figures. International reading achievement data for 14-year-old students, on the other hand, show that the mean scores of students in the United States are closer to the top of the international distribution. Among the five G–7 countries presented in figure 8.6, the United States consistently trails only France in the three measures of reading achievement.[52]

[52]The changing cast of countries included in figures 8.4 through 8.6 reflects the inconsistency with which nations participate in the various studies of international achievement.

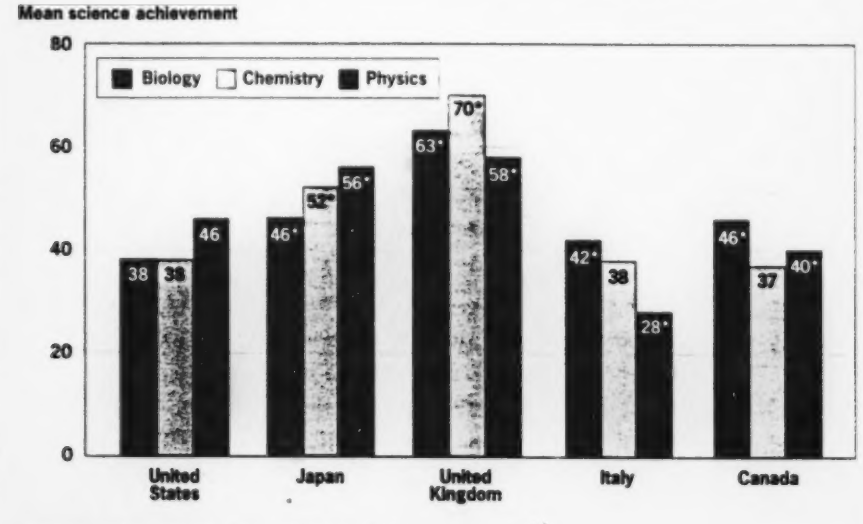
Figure 8.4
Mean mathematics achievement of students in their last year of secondary school in industrialized countries, by topic: 1980–82



*Mean score is significantly different from that of U.S. students.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *International Mathematics and Science Assessments: What Have We Learned?*, 1992, based on data from the Second International Mathematics Study (SIMS).

Figure 8.5
Mean science achievement of students in their last year of secondary school in industrialized countries, by topic: 1983–86



*Mean score is significantly different from that of U.S. students.

SOURCE: U.S. Department of Education, National Center for Education Statistics, *International Mathematics and Science Assessments: What Have We Learned?*, 1992, based on data from the Second International Science Study (SISS).

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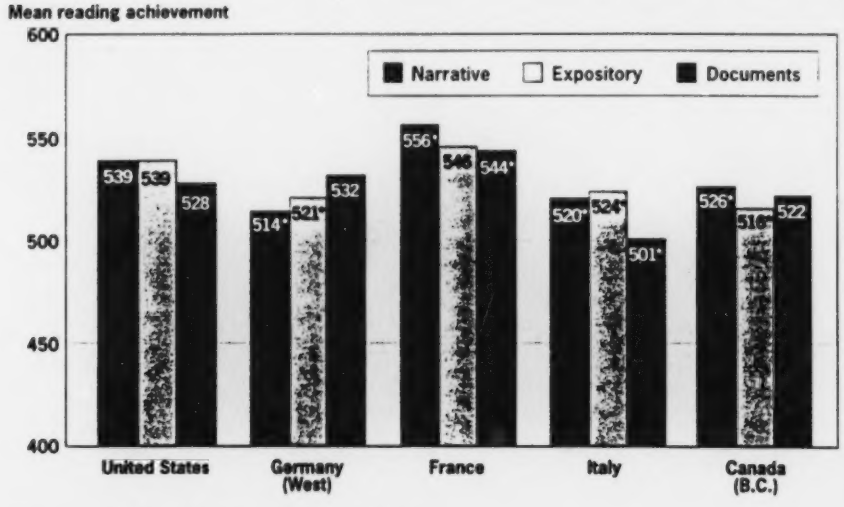
Figure 8.6
Mean reading achievement of 14-year-old students in industrialized countries, by topic: 1990–91



*Mean score is significantly different from that of U.S. students.

SOURCE: Warwick B. Elley, *How in the World Do Students Read?*, 1992, based on data from the International Association for the Evaluation of Educational Achievement Reading Literacy Study.

Data from the most recent international studies confirm the finding that the average mathematics and science performance of U.S. students is below that of students from other countries. On the mathematics test, the mean U.S. scores for both 9-year-olds and 13-year-olds were below those of most other countries (table 8.1). No country scored below the United States for 9-year-olds, and only Jordan scored below the United States for 13-year-olds. On the science test, U.S. 9-year-olds scored above their counterparts in two other countries and similar to their counterparts in the rest of the countries. But U.S. 13-year-olds trailed their counterparts in many of the other countries and surpassed only the 13-year-olds in Jordan.

The relative success of U.S. students on reading tests is also reflected in table 8.1. U.S. 9-year-olds scored higher than their counterparts in 20 of the other 22 countries included in the study. U.S. 14-year-olds also scored high in reading, equaling or surpassing their counterparts in most of the other countries. Only 14-year-olds in Finland had higher reading scores than 14-year-olds in the United States.

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Table 8.1
International distribution of academic achievement relative to the United States: 1991–92

Subject and age	Number of countries performing: Significantly higher than the U.S.	Not significantly different from the U.S.	Significantly lower than the U.S.	Number of countries in the study
MATHEMATICS				
9-year-olds	7	2	0	10
13-year-olds	12	1	1	15
SCIENCE				
9-year-olds	0	7	2	10
13-year-olds	7	6	1	15
READING				
9-year-olds	1	1	20	23
14-year-olds	1	14	7	23

SOURCE: U.S. Department of Education, National Center for Education Statistics, *The Condition of Education, 1993*; Warwick B. Elley, *How in the World Do Students Read?*, International Association for the Evaluation of Educational Achievement, Study of Reading Literacy, 1992; and Educational Testing Service, International Assessment of Educational Progress, 1992.

These results reveal that the ranking of countries by level of student achievement varies across broad areas of the curriculum (for example, mathematics, science, and reading), as well as more specific subjects within these areas (for example, arithmetic, statistics, and measurement). Furthermore, younger U.S. students tend to rank higher than older students, relative to those of the same age in other countries. Overall, the position of the United States in the international distribution of student achievement varies depending on the subject matter, age of the students, and countries in the study. The U.S. is rarely a leader among industrialized countries in mathematics and science, and is often ranked near the bottom of the international distribution of student mathematics and science achievement.

The variability in the ranking of the United States has fueled the ongoing debate over the degree to which definitive conclusions can be drawn from the data on international student achievement. Several factors are central to this debate (see review in Stedman 1994). First, critics argue that the sampling methods in the studies impede meaningful comparisons across countries. A report produced by NCES recognizes four technical weaknesses associated with sampling in the assessments: poor response rates, lack of comparable populations, variability in

sample quality and target population, and frequent small sample sizes (U.S. Department of Education 1992). However, Stedman (1994) argues that critics have exaggerated the impact of sample-related issues such as variations in high school enrollment rates, and that the problems tend to be the extreme cases.

A second criticism of the international achievement studies is that there is test bias resulting from exams that favor the curricular content of some countries over that of others. For instance, some have argued that the U.S. students are at a disadvantage in mathematics because algebra is not taught until high school and calculus until college. However, U.S. students perform relatively poorly in most mathematics subjects. Furthermore, the curricular content of the test used in the Second International Mathematics Study has been reported to be satisfactory for the United States (Travers 1987). The educational quality of the tests has been challenged on the grounds of the limitations of the multiple choice format, the short time frame for the exam, international differences in student motivation to do well, and variability in student experience with standardized testing. Stedman (1994) argues that these concerns are largely anecdotal and unsubstantiated, and that they explain little of the difference in student performance across industrialized countries.

As the debate over the validity of international assessments of student achievement continues, these potential shortcomings of the data remain unresolved, limiting our ability to report conclusively on international achievement rankings. Nevertheless, one consistent finding across the international studies is that the United States is rarely a leader nation in student achievement in mathematics and science.

DISCUSSION: IMPLICATIONS OF U.S. EDUCATIONAL ACHIEVEMENT FOR PRODUCTIVITY GROWTH

Experts differ in the significance they attach to comparisons of achievement outcomes for school subjects across countries. Bishop (1992) uses international test data to argue that the low mathematics and science performance of U.S. 17- and 18-year-olds relative to students in other countries is a major problem for the nation's future productivity.[53] Basing his results on both the growing importance of the technical elements in these fields for the changing economy and the connection between test performance and productivity, Bishop sees a threat to U.S. competitiveness. Levin and Kelley (1994) view the situation differently. Although

[53]Bishop's (1992) cross-country comparisons of test scores are based on results from the Second International Math and Science Studies.

they do not take issue with the relative position of U.S. students in international assessments as critics often do, they assert that the achievement tests behind such comparisons do not reflect the kinds of skills that are likely to increase productivity. They base their conclusions on a different body of research than that used by Bishop, citing instead teamwork and work habits as being more influential than academic skills on worker productivity.[54] Levin and Kelley agree that a threshold of basic skill levels among U.S. students will be a key element in future productivity – particularly among those at risk of not achieving these minimums in the areas of computation, communication, and reading. They see little evidence, however, that the U.S. performance on international achievement tests reveals a threat to the country's international economic competitiveness.

[54]Levin and Kelley (1994) cite two types of studies on the link between test scores and productivity. First, they argue that studies of earnings have failed to find a strong link between test scores and earnings. Second, they argue that research has found that there is only a modest connection between test scores and productivity ratings by supervisors.

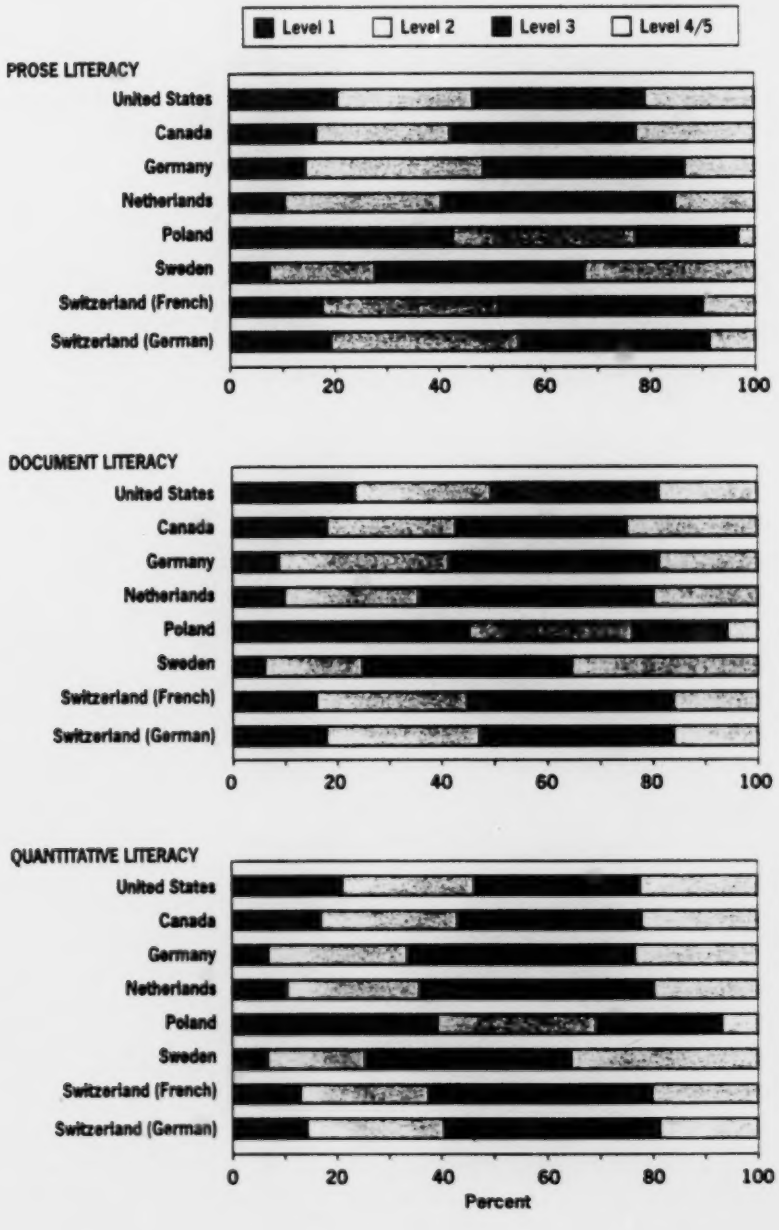
INDICATOR 18

Adult Literacy in Industrialized Countries

The previous indicator compares the skills and knowledge of students in the U.S. with students in other countries. Alternative comparisons can be made based on the literacy skills of adults in different countries. A recent study (OECD and Statistics Canada 1995) based on the International Adult Literacy Survey (IALS) addresses this issue. The IALS was conducted in several countries in Europe and North America in 1994. The survey tested the performance of respondents on the same three scales—prose, document, and quantitative—that were used in the National Adult Literacy Survey (NALS) in the United States, as is described in chapter 5.

The literacy of the U.S. population is roughly similar to that of populations in other industrialized countries. The statistics represented in figure 8.7 show that the proportion of the U.S. population in the two highest literacy levels (levels four and five) is generally comparable to other countries included in the OECD and Statistics Canada study (1995). The one exception to this finding occurs on the prose scale, where the United States has a greater proportion of high scorers than four of the other six countries included in the study. At the other end of the performance scale, the United States tends to have a higher concentration of adults in the lowest literacy level than the other countries. More than 20 percent of the U.S. sample scored at the lowest literacy level on each of the three literacy scales, while the other countries (except Poland) had less than 20 percent of the sample scoring at the lowest level on each scale.

Figure 8.7
Estimated percentage of the population in each proficiency level on three adult literacy scales, by selected countries: 1994



SOURCE: Organization for Economic Cooperation and Development and Statistics Canada, *Literacy, Economy and Society: Results of the First International Adult Literacy Survey*, 1995.

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INDICATOR 19

Training in Industrialized Countries

Some researchers have argued that the United States lags behind other industrialized countries in work force skills. Much of this alleged deficiency has been attributed to the relative scarcity of employer-provided training in the United States, especially for front-line workers (Barton 1993). According to this view, U.S. producers rely too heavily on informal learning-by-doing as their primary method of skills development, and they underinvest in more rigorous training. This view has recently prompted policymakers to consider policy changes, such as instituting minimum employer training investments, to encourage the expansion of employer-provided training in the United States.

Despite the widespread belief that U.S. workers are undertrained, the available training data are not really adequate to determine whether this belief is accurate. In fact, the data on training rates and training expenditures in industrialized countries (table 8.2) fail to indicate a substantial training deficiency in the United States. According to these data, the United States has neither the highest nor the lowest rate of training participation among industrialized countries. Findings for training expenditures are similar: the United States and Germany appear to be about equal, second only to France among the countries for which there are data. The data in table 8.2, however, come from a variety of sources and are based on different worker populations, different periods, and different definitions of training; therefore, cross-country comparisons of these data may be inappropriate.

Lynch (1994) suggests that, even if comparisons of the data in table 8.2 are appropriate, the similarities across countries may mask two important types of underinvestment in training in the United States. First, U.S. companies in certain sectors spend substantially less on training overall and provide their nontechnical, nonmanagerial employees with more limited training than competitors in other countries provide to comparable workers. For example, Berg (1994) estimates that German auto firms devote from 1.5 to 10 times more time than comparable U.S. companies to technical training. Second, in some sectors, the level of expenditures or number of training hours may be the same in the United States as in other countries, but because of lower initial skills of U.S. workers, training in the United States is not sufficient to bring trainees up to the proficiency levels of workers in other countries. For example, Mason (1990) compared the training of workers in the nuclear power industries in the United

States and Europe. He found that half of all technician training in the U.S. nuclear industry is fundamental, including remedial education, whereas training for European technicians covers more advanced study of nuclear engineering and plant administration. Mason (1990) asserts that the difference reflects the superior educational preparation of European workers entering the industry as compared with their American counterparts.

Table 8.2
Training activity, by country

	Workers receiving formal training[a] (percent)	Average training expenditure (percent of total wage bill)
United States	16.8	1.8[c]
Canada	6.7	0.9
West Germany	12.7	1.8
United Kingdom	14.4	1.3
France	32.0	2.5
Netherlands	25.0	1.5
Sweden	25.4	NA
Japan	36.7	0.4[d]
Australia	34.9[b]	1.7
Norway	33.1	NA

NA = not available.

[a]Period over which training incidence is measured varies by country. For example, the figure for the United States refers to the percentage that ever received formal training from the current employer, while the figure for Japan refers to training in the past two years (see Lynch 1994 for further discussion of these data).

[b]Received in-house training.

[c]Based on a survey of large firms conducted by *Training Magazine*.

[d]Training expenditures as a percentage of monthly labor costs, but excludes trainees' wages.

SOURCE: Lisa M. Lynch, "Introduction," in L. Lynch, ed., *Training and the Private Sector: International Comparisons*, 1994.

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CONCLUSIONS

■ *Educational attainment levels among the group of industrialized countries are becoming more similar over time. The United States maintains a strong lead over all countries but Japan in college completion, but secondary school attainment in most other countries is converging with that of the United States.*

■ *Although the population in the United States has higher educational attainment than that in most other industrialized countries, students in the United States do not have higher achievement levels than students in other industrialized countries. In particular, elementary and secondary students in the United States have far to go in mathematics and science before their test scores assume the lead.*

■ *Although existing data are insufficient to determine the adequacy of worker training in the United States, the data do show that the United States ranks neither highest nor lowest in rates of participation in and expenditures on training among industrialized countries. Despite the similarity in training rates and expenditures, U.S. employers in certain sectors may spend substantially less on training than similar employers in other countries, especially on their nontechnical, nonmanagerial employees. In addition, U.S. workers may not receive as sophisticated training as comparable workers in other countries because they are not as well educated as their foreign counterparts and are not as well prepared for higher-level training.*

■ *Overall, the picture of education among developed nations suggests that the trends in education do play a role in the trends in worker productivity. The convergence in worker productivity among nations parallels the convergence in educational attainment and reflects, at least partly, the relatively high educational performance of students outside the United States.*

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